12-2008

# Benchmarking Regional Competitiveness: The Role of a Region's Economic Legacy in Determining Competitiveness

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# BENCHMARKING REGIONAL COMPETITIVENESS: THE ROLE OF A REGION'S ECONOMIC LEGACY IN DETERMINING COMPETITIVENESS

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A Dissertation
Presented to
the Graduate School of
Clemson University

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In Partial Fulfillment
of the Requirements of the Degree
Doctor of Philosophy
Applied Economics

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by
Rebekka Martin Dudensing
December 2008

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# ABSTRACT

Studies benchmarking or indexing regional competitiveness are increasingly common in the popular and professional press. Indices are popular because they condense a large amount of data into a single number or grade that facilitates the easy comparison of regional economies. However, researchers question both the benchmarking methodology and the appropriateness of applying one region's successful economic development practices to a dissimilar region. The goal of this study is to improve the benchmarking methodology by identifying possible variable weights for three competitiveness outcomes (growth in population, employment, and per capita income) and exploring whether policy inputs (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) interact with a region's industrial structure and legacy (establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage) to affect competitiveness. Data describing the economic characteristics of 151 metropolitan statistical areas in the US South are used to estimate the competitiveness outcomes under two economic growth model specifications. The estimation results indicate that variable weights should differ across competitiveness outcomes and that the effect of policy inputs on competitiveness outcomes is influenced by the region's industrial structure and legacy. It is therefore difficult to construct meaningful indices, and researchers could assist policymakers by providing less aggregated data and more thorough explanations of how variables interact to influence competitiveness outcomes.

## ACKNOWLEDGEMENTS

Many people contributed to this research. Dr. David Barkley, my major professor, spent countless hours providing research recommendations and reviewing this manuscript. Drs. Michael Hammig, David Hughes, and John Warner also provided valuable advice as they served on my dissertation committee. Drs. William Bridges, Pat Girard, and Mark Henry provided additional assistance with statistical aspects of the research. Daniel Eades and Jeffrey Dudensing helped to locate and tabulate data. Rich Bryden of Harvard University supplied a summary file of Cluster Mapping Project data for the Southern Census Region. Martha Ervin assisted with formatting. Each of these people receives my sincere thanks.

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# CHAPTER 1

# INTRODUCTION

Studies benchmarking or ranking the competitiveness of cities and regions are increasingly common both in the academic literature and in the popular press. These indexing studies often score or rank regions based on measures of inputs or resources available (e.g., human capital, financial capital, R&D funding, and infrastructure) or outcomes of the competitiveness process (e.g., population, employment, and income). Indices are popular because they are easy to use and because their statistical underpinnings and production by independent organizations lend an aura of objectivity to the studies (Bristow, 2005; McCann, 2004).

Some studies are intended for use by regional public officials, businesses, location consultants, and developers; other studies appeal to the general population and the media. Examples of indices intended for academic and policy circles include the metropolitan and state *New Economy* indices (Atkinson and Correa, 2007; Atkinson and Gottlieb, 2001), the Milken Institute's *Best Performing Cities* (DeVol et al., 2007), and the Beacon Hill Institute's *State Competitiveness Report* (Haughton and Murg, 2002). Kiplinger's *Best Cities* (Florida, 2007; Stolarick, 2008) and *Money Magazine's Best Places to Live* (*Money Magazine*, 2008) indices are published for the general population.

An increasing interest in regional competitiveness in the popular and professional literature is attributed to the perception that absolute competitive advantage rather than comparative advantage is the key to regional economic development (Porter 1985, 1990).

Successful regions specialize in the production of goods and services for which local firms are the efficient producers. At the same time, firm productivity is affected by the quality of the regional business environment and the region's institutions, industrial structure, and economic legacy. Competitiveness is based on rare, inimitable, and non-tradable factors, and producers may take advantage of these agglomeration economies to enhance competitive advantage and earn a greater share of global markets (Camagni 2002a; Ma, 2000).

## Benchmarking Regional Competitiveness

*Regional Competitiveness Defined.*

The benchmarking of regional competitiveness requires a working definition of the term "competitiveness." For some researchers, regional competitiveness is synonymous with productivity (Porter, 1990, 2002). Other researchers use a broader definition of competitiveness that includes quality of life measures (Organization for Economic Cooperation and Development, 1996; Storper, 1997). For example, Storper (1997, p. 20) defines regional competitiveness as "the capability of a sub-national economy to attract and maintain firms with stable or rising market shares in an activity, while maintaining or increasing standards of living for those who participate in it." Storper's definition has been adopted by several competitiveness studies, including Huggins (2003) and Kitson et al. (2004).

*Competitiveness Indices.*

Benchmarking studies are appealing because they are simple and require little analytical expertise (Fisher, 2005). Indices consolidate a large amount of information into a single number or grade. Policymakers or advocacy groups can cite index scores or rankings in promoting successful regions or in garnering support for the development of lagging regions. The high-scoring regions in benchmarking studies often serve as case studies in successful economic development. When updated regularly, indices show how regions' competitive positions shift over time (e.g., the *State New Economy* indices by Atkinson et al., 1999; Atkinson, 2002; and Atkinson and Correa, 2007). Therefore, indices can provide support for long-term economic development policies that span multiple election cycles.

Benchmarking studies are often criticized regarding the methodologies used to construct the indices and the usefulness of the resulting rankings. Atkinson (1990) and Fisher (2005) criticize many studies' methods of selecting variables, combining disparate measures, and weighting variables and sub-indices. Fisher points out that policy recommendations based on benchmarking studies are valid only if the indices are good predictors of regional economic outcomes. However, Greene et al. (2007) find little evidence of a causal relationship between the measured variables and regional competitiveness in 22 benchmarking studies. Dunning et al. (1998) also find that benchmarking studies do not identify the reasons that places grow or stagnate. Boschma (2004) and McCann (2004) warn that regional policymakers should exercise care in comparing regions with different economic structures and in generalizing policies across regions.

A region's competitiveness and the efficacy of policies to enhance competitiveness may be influenced by the region's industrial structure and legacy. A region's historical industries influence both its current industries and its residents' quality of life (Turok, 2004). Consequently, history and geography can be expected to influence economic responses to policy changes (Kenny and Williams, 2001; Kitson et al., 2004). Most benchmarking studies ignore the roles of industrial structure and legacy, and when industrial legacy variables are included in benchmarking studies (e.g., Eberts et al., 2006, and Gardiner, 2003), they are included as policy inputs rather than as environmental factors that influence the policy inputs.

Given the criticisms directed toward benchmarking studies, particularly the question of their usefulness, one might wonder why academics should continue to measure regional competitiveness. Atkinson writes in the summary of his 1990 (p. 49) critique, "It appears that business climate studies are here to stay." Almost 20 years later, Greene et al. (2007) accept benchmarking studies as a part of an audit culture and a neo-liberal approach to economic governance. Fisher (2005) supposes that indices and rankings are created for their ease of use and media popularity, and therefore he offers suggestions to improve the benchmarking methodology. For example, Fisher recommends that the variables selected should be relevant to economic growth, appropriate to the research questions, and weighted to reflect their influence on economic outcomes.

**Study Objectives**

The goal of this study is to explore possible improvements to the methodology of benchmarking studies. The study tests two principal hypotheses. First, variables reflecting regional inputs are predicted to affect various outcome measures differently, and thus, different variable weights are hypothesized to be appropriate in estimating different outcome measures (e.g., growth in population, employment, and income). That is, regressions of each outcome on input variables are expected to result in different coefficients. For example, education levels are predicted to be more strongly associated with per capita income growth than population growth. Similarly, the percent of the labor force with a high school diploma may be associated with growth in per capita income while the percent of adults with college degrees may have a greater association with job growth.

Second, policy inputs are hypothesized to interact with the industrial structure and legacy of a region to influence competitiveness outcomes. Interaction terms between the input measures and the industrial legacy measures in the regression models are predicted to be significant, and significance will show that policy inputs have different effects in regions with different industrial structures and legacies. For example, an increase in the percent of the labor force with a college degree might have a stronger relationship to employment growth in regions with a higher percentage of employment in skill-intensive industries. A role for industrial structure and legacy in regional competitiveness suggests that (1) policymakers should be cautious in applying lessons learned from case studies of other regions to their own economy and (2) uniform variable weighting across all regions in a competitiveness index will be inappropriate and misleading.

**Summary of Findings**

Variables representing competitiveness inputs and industrial structure are selected based on reviews of past studies, and data are collected for 151 metropolitan statistical areas (MSAs) in the Southern US Census region. Factor analysis is used to combine the explanatory variables into groupings of variables with common underlying characteristics that correspond to the themes of growth identified in the literature on regional economic competitiveness. Policy input groupings (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) include variables that can be influenced by regional economic development policies and strategies. Industrial structure/legacy variables (establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage) reflect a region's economic history and structure. The legacies associated with a region's historical industries are difficult to change in the short run, but industrial structure/legacy measures describe the environment in which policy inputs must operate to improve competitiveness outcomes (growth rates of population, employment, and per capita income).

Estimations of regional economic growth model specifications based on Glaeser et al. (1995) and Carruthers and Mulligan (2008) both support the first hypothesis that variables influence different outcomes differently. For example, innovation inputs and labor employability are both positively related to per capita income growth but negatively related to employment growth. Additionally, outcomes (growth in population, employment, and per capita income) are significantly affected by different variables. For example, in the Carruthers-Mulligan model specification, innovation inputs are associated with changes in population and employment growth while knowledge workers are associated with changes in per capita income growth. This suggests that variable weights in competitiveness indices should vary depending upon the competitiveness outcome measured.

Estimations of the Glaeser et al. and Carruthers-Mulligan specifications of the growth model also support the second hypothesis that metropolitan economies with different industrial structures and legacies respond differently to economic development policies and strategies. For example, improved labor employability has a more negative relationship to population and employment in regions with a relatively large number of small businesses, but, at the same time, labor employability has a more positive relationship to income growth in regions with many small businesses. Similarly, entrepreneurship is associated with greater income growth in regions with more small businesses and industrial specialization. This suggests that it may be appropriate to weight variables differently in regions with different economic structures and histories and that policymakers should be careful in drawing conclusions from case studies of metropolitan areas with different industrial structures and legacies.

**Organization of Paper**

The paper is organized as follows. The second chapter contains a review of the literature on regional competitiveness and its measurement. The first half of the chapter describes the debate about how competitiveness is defined, explains the sources of regional competitiveness, and acknowledges the benefits and drawbacks to using competitiveness as an economic development strategy. Three conceptual models of regional competitiveness are described, and additional models are provided in Appendix A. The second half of the literature review describes the evolution of competitiveness benchmarking. Three examples of benchmarking surveys are explained in depth, and additional examples are included in Appendix B. Finally, suggested improvements to measurements of competitiveness are reviewed. This study attempts to address those concerns while building on the positive aspects of prior research.

The third chapter describes the data and statistical methods that are used in the study. The empirical growth models for selected economic outcomes (2000 to 2006 growth rates of population, employment, and per capita income) are constructed to reflect the parameters of a conceptual model of competitiveness based on Gardiner (2003) and the National Competitiveness Council (2007). Empirical models based on Glaeser et al. (1995) and Carruthers and Mulligan (2008) are developed to test the sensitivity of the results to the model specification. Data for variables selected to represent competitiveness inputs and industrial structure/legacy are collected for 151 MSAs in the US South, and these variables and their sources are described in the second half of the chapter.

The fourth chapter presents the results of the study. Statistical techniques are used to combine explanatory variables into uncorrelated variable groupings with common underlying factors. The 2000 to 2006 metropolitan growth rates of population, employment, and per capita income are modeled using the 1990 values of explanatory variables and the 2000 values of lagged outcome variables to avoid unreliable coefficients resulting from correlation or endogeneity in the model estimations. Estimations of the Glaeser et al. and Carruthers-Mulligan model specifications result in different coefficients and levels of significance. However, both specifications indicate that variables should be weighted differently when measuring different outcomes. Interaction terms in both specifications indicate that metropolitan areas with different industrial structures and legacies respond differently to policy inputs. A summary of the results, conclusions, and recommendations for future research are provided in the fifth chapter.

# CHAPTER 2

# LITERATURE REVIEW

## Introduction

Studies benchmarking or ranking regional competitiveness are popular because indices and rankings are straight-forward, easy to understand, and carry an aura of objectivity. Published indices often measure the competitiveness of a city-region or state by its resource inputs (e.g., labor force quality, innovation, and entrepreneurship) or competitive outcomes (e.g., jobs and income). However, studies that index competitiveness are criticized regarding the methodologies used to construct the indices and the usefulness of the resulting rankings. One of the key problems with measuring competitiveness is that there is little agreement about what the term means and, consequently, what is or should be measured.

This chapter first explores the breadth of definitions of regional competitiveness and the concept's foundations in competitive, as opposed to comparative, advantage. Section two describes some models of regional competitiveness. Section three discusses the determinants of competitive advantage and the competitive environment. Section four explains the benefits and drawbacks of developing policies to enhance competitiveness. Section five is dedicated to the benchmarking, or measurement, of regional competitiveness. The role of indices is discussed, three benchmarking studies are reviewed, and the benefits and drawbacks of benchmarking are summarized. Finally, suggested improvements to indices are described, and the role of industrial legacy in regional competitiveness and its measurement is presented. A discussion of how this project contributes to the literature concludes the chapter.

## Definition and Sources of Regional Competitiveness

### *Regional Competitiveness Defined*

The strategies by which a region competes determine whether the region engages in zero-sum competition or strives for positive-sum competitiveness. Competition based on low wages, flexible labor, and low taxes prevent regions from improving labor skills and raising wages (Malecki, 2004). Malecki identifies this low cost competition as the "low road" competition or "smoke-stack chasing" common in the Southern United States (US South) during the 20th century (Cobb, 1993; Malecki, 2004; Rork, 2005). On the other hand, the "New Economy" concept of regional competitiveness is a "high road" competition and involves raising a region's skill levels, incomes, and standards of living.[1]

Many authors credit Michael Porter (1990) with popularizing the principle of competitiveness, sometimes called competitive advantage, as the ability of firms and industries to gain and retain a share in contested global markets (Bristow, 2005; Budd and Hirmis, 2004). However, Atkinson describes the increasing importance of competitive advantage in terms of flexibility, productivity, and innovation in 1990; Harvey indicates that regions can work to improve their competitive position in 1989; and Scott and Lodge define regional competitiveness in 1985.

Researchers define competitiveness in a number of ways. Porter (1990, 2002) defines competitiveness solely in terms of productivity.[2] Krugman (1990, p. 9) agrees that competitiveness hinges on productivity, and he states that "[p]roductivity isn't everything but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker." Alternatively, Gardiner et al. (2004, p. 1049) describe this focus on productivity as "perverse" because firm downsizing produces more productive firms, but it does not increase regional output and it may make residents worse off.

Other researchers define competitiveness more broadly. Turok (2004) posits that a definition of competitiveness should include a region's relative ability to export local goods, the efficiency or productivity of local resources in producing goods of value, and the extent to which resources are used. Storper (1997, p. 20) defines regional competitiveness as "the capability of a sub-national economy to attract and maintain firms with stable or rising market shares in an activity, while maintaining or increasing standards of living for those who participate in it."[3]

Many studies combine elements of both Porter's and Storper's definitions. A 1999 European Commission (EC) report (p. 75) cited by Gardiner (2003, p. 4) defines competitiveness as "…the ability to produce goods and services which meet the test of international markets, while at the same time maintaining high and sustainable levels of income or, more generally, the ability of (regions) to generate, while being exposed to external competition, relatively high income and employment levels." The EC definition identifies both the success of firms and the welfare of residents as competitiveness outcomes and recognizes that these outcomes occur in the context of an economic environment over which policy makers exert only partial control.

Kitson et al. (2004, p. 992) define competitiveness as "…the success with which regions and cities compete with one another in some way. This might be over shares of (national, and especially international) export markets. Or it might be over attracting capital or workers." The Kitson et al. definition explicitly recognizes both the breadth of competitiveness measures and the range of policy goals over which those measures may be applied. Kitson et al. (2004, p. 997) use their definition to identify competitive regions as "places where both companies and people want to locate and invest in."

Bristow (2005) asserts that both the Storper (1997) and Porter (1990) definitions are derived from a definition of competitiveness first developed by Scott and Lodge (1985) for the US and later used by the Organisation for Economic Co-operation and Development (OECD, 1992) and several national governments. Specifically, Scott and Lodge (1985, p. 3) define national competitiveness as "…a country's ability to create, produce, distribute, and/or service products in international trade while earning rising returns on its resources." To Scott and Lodge, these rising returns are equivalent to rising standards of living for residents, but it is firms who do the actual competing.

Budd and Hirmis (2004, p. 1016) cite two principal sources in describing the meaning and components of competitiveness. First, the Organization for Economic Cooperation and Development (1996) define national competitiveness as "...the degree to which [a nation] can, under free and fair market conditions, produce goods and services which meet the test of inter-national markets, while simultaneously maintaining and expanding the real incomes of its people over the long term." Second, the United Kingdom Department of Trade and Industry (1998) defines competitiveness as "…the ability to produce the right goods and services of the right quality, at the right price, at the right time. It means meeting customer needs more efficiently and more effectively than other firms." This definition clearly points to absolute rather than comparative advantage. Budd and Hirmis stress the importance of firm efficiency arising from imperfect competition and economies of scale. Budd and Hirmis explain that firms' efficiency contributes to both the comparative advantage and the competitive advantage of the region.

*Sources of Regional Competitiveness: Comparative Advantage vs. Competitive Advantage*

Comparative Advantage. The concept of competitiveness derives from the ability of a region's firms to compete in international trade. Trade is an important component of economics, and it becomes more important as the region becomes smaller. Relatively, more trade is conducted between cities, counties, and states than between countries. Krugman (1996) and Camagni (2002a) agree that trade is ultimately about imports. Each region strives to maximize its imports of goods and services in order to maximize its standard of living. Regions import goods because it is more efficient to import the goods than to produce them. Exports, while the focus of most economic development policy (e.g., export base theory), simply provide the means to pay for a region's imports (Krugman, 1996).

The principle of comparative advantage states that all countries or regions benefit from trade by specializing in the production of the good they produce most efficiently or least inefficiently. This traditional view, usually attributed to Ricardo (1817), holds that a region can achieve positive gains from trade without being the low cost producer of any good. Wages, prices, production patterns, and world market size are determined simultaneously, and growth in productivity and output feed back to wages and demand, respectively (Krugman, 1996). Consequently, a nation's balance of trade does not indicate its strength or weakness. Countries do not behave like competing corporations; on the contrary, if one country succeeds, its trading partners are likely to succeed as well (Krugman, 1998).

Competitive Advantage. Porter (1985) introduces the concept of competitive advantage at a national level as a substitute for traditional Ricardian comparative advantage. Porter claims that nations export those goods and services that they are able to produce more profitably than other nations. Camagni (2002a) claims that the principle of competitive advantage is more appropriate for sub-national regions than is the principle of comparative advantage. Camagni claims the principle of comparative advantage does not hold for sub-national regions because these smaller regions lack price-wage flexibility and the ability to manipulate the value of their currency. These constraints differ from those of international trade or the Ricardian textbook application of trade between two people because regions are not fully autonomous. Wages set by state or national laws are not linked to regional productivity, and adjustment to trade balance occurs through labor mobility rather than the depression of wages. The principle of comparative advantage also fails to account for increasing returns due to agglomeration economies (Camagni, 2002a; Malecki, 2004).

Barney (1991) and Ma (2000) note that competitive advantage is based on resources that are rare, valuable, inimitable, non-tradable, non-substitutable, and firm- and region-specific. In fact, Ma claims that a region may possess multiple competitive advantages that are compounded to make the region the most efficient producer of a good or service, thus providing the region an absolute advantage in its production. Therefore, at the regional level, competitiveness is based on the principle of absolute advantage (Camagni, 2002a; Malecki, 2004). A region's firms must be the most efficient producers of exported products because sub-national governments have little or no control over their wages or exchange rates. In essence, regions compete to attract investment and labor and to identify a productive role for the region within the international economy (Camagni, 2002a). Under a principle of absolute advantage based on competitive advantages, Camagni refutes the premise that each region will always be afforded some specialization and role in international trade. However, proponents of competitive advantage propose that countries and regions can develop their competitive positions and capture a share in global markets by specializing in unique economic activities and by fostering novel market interactions (Budd and Hirmis, 2004; Kitson et al., 2004).

**Conceptual Frameworks for Regional Competitiveness**

Many authors have proposed conceptual models to describe competitiveness. Some frameworks simply attempt to account for factors and linkages hypothesized to affect competitiveness (e.g., Budd and Hirmis, 2004; Kitson et al., 2004). Other conceptual models serve as the basis for benchmarking studies and are driven by data considerations (e.g., Steinle, 1992). These frameworks include factors for which data are available to the researchers. Clearly, there are factors of competitiveness that are difficult to measure either directly or by proxy. Inclusion of these elusive factors in a conceptual framework is complicated by the need to include them in a statistical model as well. Three conceptual models of competitiveness are presented in this section. Additional models are provided in Appendix A.

*Porter Diamond and Variants*

One of the most cited conceptual models of regional competitiveness is developed by Porter (1998a).[4] The Porter Diamond diagrammatically models the principal determinants of local industry growth (Figure 2.1). The diamond shows the interaction of demand conditions; factor (input and infrastructure) conditions; firm strategy, structure, and rivalry; and related and supporting industries. Porter explains that government policies also affect each of the four determinants of growth, serving as a catalyst to promote growth. In addition to the government, other institutional elements are included in the factor conditions component of the diamond. The Porter Diamond reflects the importance Porter places on productivity resulting from clusters, inter-firm competition, and urbanization economies. Porter concludes that a set of productive industries results in a competitive region. Many authors (e.g., Budd and Hirmis, 2004; Kitson et al., 2004) have elaborated upon the Porter Diamond model, and variants of the diamond model are included in Appendix A.

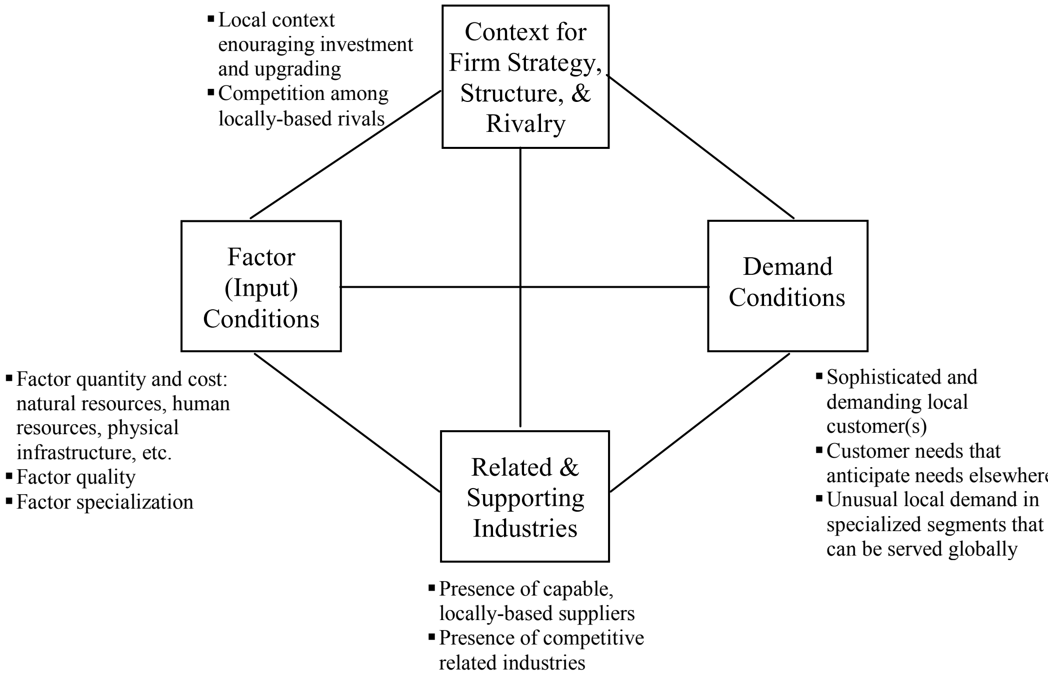


Figure 2.1. Porter Diamond model of competitiveness.

*Input-Output-Outcome (Hierarchical) Models*

Greene et al. (2007) find input-output-outcome models in 22 regional benchmarking studies. The simple model described by Greene et al. has no feedback mechanism (Figure 2.2). Inputs (e.g., innovation and various forms of capital) affect outputs (e.g., gross domestic product [GDP] per capita) that in turn influence outcomes (e.g., earnings and employment). Outputs are productivity measures, and outcomes represent measures of quality of life for local residents. These outcomes are influenced by the economic, policy, environmental, and social factors within the region.

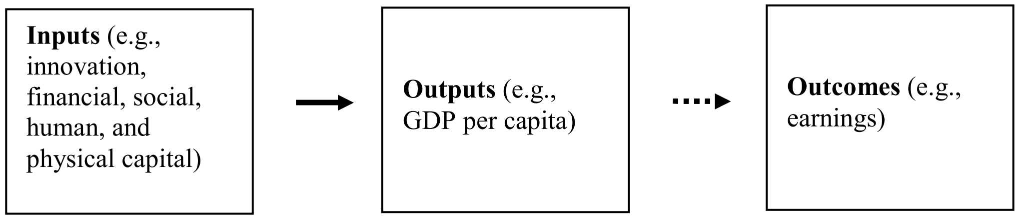


Figure 2.2. Input-output-outcome model of regional competitiveness (Greene et al., 2007).

*Pyramid Models*

Gardiner et al. (2004) and Ireland's National Competitiveness Council (2007) arrange the input-output-outcome model into a pyramid. The base of the pyramid includes the basic inputs or foundations of economic development. Middle layers filter and focus policy decisions and economic development efforts through the region's economic structure to achieve the desired outcomes of competitiveness. The outcomes at the top of the pyramid can be measures of outputs (e.g., gross regional product) and/or outcomes (e.g., quality of life). The pyramidal structure is appealing from a policy perspective because it implies that regions can build on their regional characteristics and their competitive advantages to achieve their target outcomes.

Gardiner et al. (2004) create their conceptual pyramid framework by combining several other conceptual models (Figure 2.3).[5] Gardiner et al. identify 13 sources of competitiveness, including economic structure, innovation, small business development, and workforce skills. These sources influence labor productivity and the employment rate, and the two revealed competitiveness measures act together to determine gross regional output. Strong regional economic performance ultimately translates into greater quality of life and a higher standard of living.

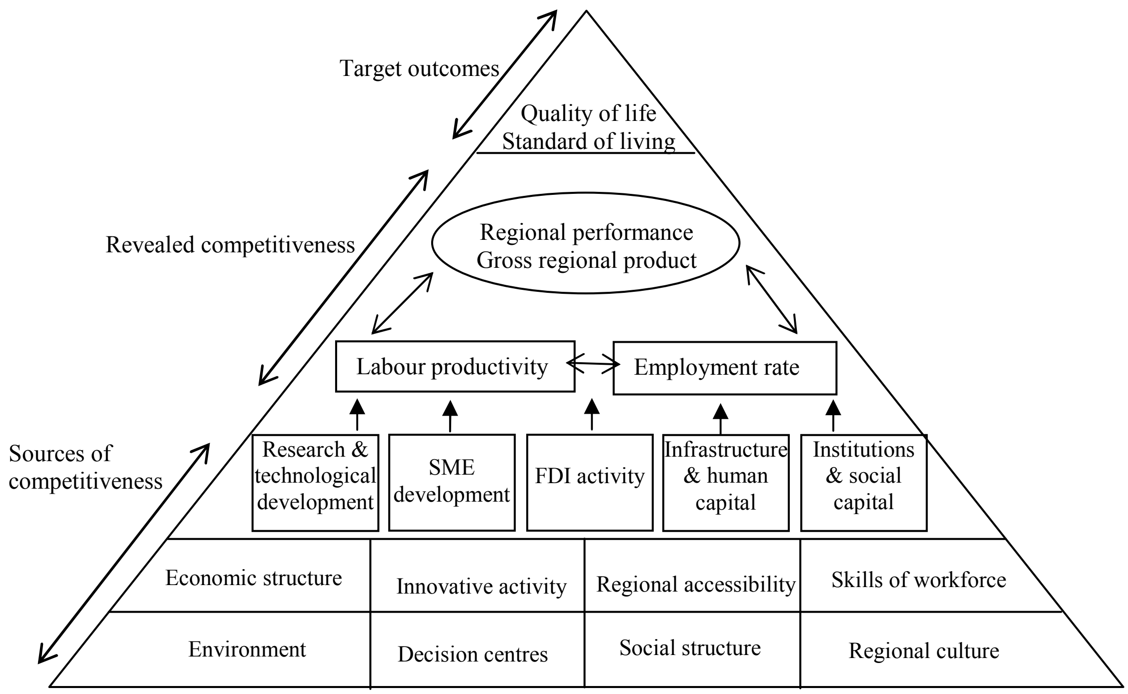


Figure 2.3. Pyramid model of competitiveness (Gardiner et al., 2004).

*Determinants of Regional Competitive Advantage*

The existence or relevance of regional competitiveness is much debated. For example, Krugman (1998) claims that competition is a firm activity and, because regions do not compete in the sense that firms do, regions do not go out of business as firms do. Camagni (2002a) counters that regions can, in fact, be forced “out of business” if their firms are less efficient and competitive than those of other regions. History has shown that cities and regions can decline in importance, sometimes to the point of non-existence (e.g., ghost towns). Greene et al. (2007) posit that while a region may not go out of business as a firm does, a region may become locked in a spiral of decline. Gardiner et al. (2004) find that regional productivity in the European Union converged by only about one percent per year from 1980 to 2001, and they acknowledge that regional productivity differences may increase over time.

Scott (1985) suggests that a region's competitive position increasingly depends more on man-made advantages and less on natural advantages. In a competitive region, those man-made advantages should be rewarded by higher real incomes (standards of living) generated through specialization and trade. Productivity is crucial to increasing standards of living, but Scott also recognizes the importance of income distribution in competitive regions. From a national perspective, Scott (1985, p. 15) suggests the determinant of competitiveness is whether the "economy has and is likely to continue to generate rising returns both to labor and capital while maintaining its various international commitments—particularly its commitment to an open trading system."

Camagni (2002a) agrees that traditional economic factors such as natural resource endowments and the availability of labor and capital are becoming less important in advanced countries. He claims that, from a macroeconomic perspective, the New Economy relies on increasing returns resulting from cumulative development processes and the agglomeration of economic activities. From microeconomic and microterritorial perspectives, Camagni explains that the interaction of innovative firms and proactive governments produces strategic advantages. Firms use locations as competitive tools. Camagni identifies several locational factors as critical to regional competitiveness: firm productivity, innovation inputs, knowledge workers, labor employability, and entrepreneurial environment.

Firm Productivity. Competition between firms results in the exit of inefficient firms, a reduction in X-inefficiency or managerial slack, and an increase in firms' innovative capacities. Efficient and innovative firms are likely to lower their average costs and prices and increase their market shares (Greene et al., 2007; Turok, 2004). A firm's competitiveness is essentially equivalent to its productivity relative to its competitors (Bristow, 2005). Some researchers regard firm productivity as an outcome of the competitive process (Eberts et al., 2006; Kitson et al., 2004; Porter, 1990), while other researchers consider productivity an intermediate input influenced by additional factors such as innovation and human capital (Greene et al., 2007; Huggins, 2004).

Regional competitiveness is a function of more than aggregate firm productivity. Cities, states, and other regions are not profit maximizers. Regional competitiveness includes economic, institutional, and social or quality of life components (Bristow, 2005; Greene et al., 2007; Kitson et al., 2004; Storper, 1997). Nevertheless, firm productivity remains an important factor in regional competitiveness (Krugman, 1990). Porter (2003a) asserts that regional competitiveness is most heavily influenced by firm productivity in terms of the value of the goods produced and the efficiency with which they are produced. Yet, firm productivity also is influenced by the quality of the regional business environment that includes the presence of innovation inputs, knowledge workers, a highly employable skilled labor force, and an entrepreneurial environment.

Innovation Inputs. Feldman (2000, p. 373) defines innovation as "the novel application of economically valuable knowledge," and Acs (2002) and Audretsch (2002) find that innovative activity is the basis of regional competitiveness. Camp (2005) suggests that entrepreneurship and innovation are co-drivers of regional growth and that entrepreneurial regions are associated with higher levels of technology. Innovation is often measured using patents and research and development (R&D) expenditures or employment (Greene et al., 2007; Tuerck et al., 2007b, 2008). Steinle (1992) notes that, as a rule, economic growth is accompanied by R&D; however, Jaffe et al. (1993) find that innovation is a highly localized process, and therefore the economic development resulting from innovative activities is highly localized.[6]

Knowledge Workers. Florida (2002a, 2002b) proposes that the presence of highly educated, creative workers, whom he calls the "creative class," stimulate economic development by starting and growing businesses and by attracting other high-human capital workers to the region. Florida's creative class tends to be highly educated and work in occupations that require creativity, including professional, scientific, and technical jobs in addition to artistic occupations. Florida claims that the creative class prefers communities that offer a range of amenities and are tolerant of a variety of ethnicities and lifestyle choices. Consequently, Florida models regional economic development based on educational attainment and the presence of bohemians (people in creative occupations), ethnic diversity, and coupled gays.[7]

Alternatively, Glaeser (2005) argues that educational differences rather than creative class differences explain almost all differences in regional growth. Donegan et al. (2008) find that traditional indicators of human capital and industry composition predict metropolitan jobs and income growth as well or better than Florida's talent, technology, and tolerance indices. Still, Garmise (2006, p. xvi) calls creative workers the "infrastructure of the knowledge economy," and many studies use measures of high-tech and other creative workers to explain regional growth (Atkinson and Correa, 2007; Devol et al., 2007; Eberts et al., 2006). [8]

Labor Employability. Competitiveness in the knowledge economy depends on the availability and skills of the labor force (Garmise, 2006). Bloom et al. (2007) and Eberts et al. (2006) find that an increase in the proportion of the working age population relative to the total population enhances economic growth. Other studies find that regional economies with higher labor force participation rates perform better (Tuerck et al., 2007b, 2008).

Numerous studies show that the quality or education level of the workforce is critical in driving economic growth (Eberts et al., 2006; Lucas, 1988). In the knowledge economy, a well-educated workforce provides flexibility and adaptability in production, and highly educated workers are more likely to hold high-tech jobs and other high-wage jobs (Florida, 2002; Glaeser, 2005; Glaeser and Saiz, 2003). In addition, Hanson (2000) finds evidence of human capital externalities that raise regional wages.

There is not a consensus in the literature on what level of eduction is most important for regional competitiveness. For example, Glaeser et al. (1995) note that the education level of the overall workforce (e.g., the percent of the workforce with at least a high school degree) is more important to economic development than is the percent of the workforce with a college education or higher. Alternatively, Huovari et al. (2001) find that current enrollment in higher education programs also measures competitiveness because people respond to current opportunities and because the education of the future workforce promotes future competitiveness. [9]

Entrepreneurial Environment. A larger number of entrepreneurs and resources to support those entrepreneurs contribute to a greater number of firms competing in the market.[10] Schumpeter (1942) explains the importance of interfirm competition to an industry as a function of industry structure, including both firm size and barriers to entry. If there are many firms, each with a few employees, firms compete both for employees and for market share. Schumpeter describes the closing of less innovative and less productive firms and the opening of new firms as “creative destruction.”[11] Thus, interfirm competition enhances innovation and productivity in the region. Davis et al. (2008) also find that creative destruction results in a net gain in employment; the employment growth attributable to new firms is larger than the job losses caused by exiting firms.[12]

The local economic benefits attributed to entrepreneurs may go beyond starting new businesses and hiring employees. Small, locally-owned firms are likely to build supply linkages with other local companies (Barkley, 2001; Markusen, 1996). Entrepreneurs often are personally invested in their communities. Local business owners benefit from and contribute to the region’s social capital, and they tend to spend more of their profits locally because they usually live in the region where their profits are earned (Barkley, 2001; Markusen, 1996).

*Industry Structure and Regional Competitiveness*

Many researchers question whether it is reasonable to expect economic development and competitiveness strategies and policies to be equally applicable to regions of varying sizes, industrial bases, and histories (Bristow, 2005; Dunning et al., 1998; Fisher, 2005; Greene et al., 2007). A region's industrial legacy is made up of the types of businesses, labor, infrastructure, and institutions that have formed over time in response to the region's historical industrial development. Industrial legacy is persistent, and it affects an economy's competitiveness and its response to policy initiatives (Eberts et al., 2006; Kitson et al., 2004).[13] For example, a region with low educational levels is unlikely to succeed in forming a cluster of knowledge-based businesses. A region's sources of competitiveness (e.g., innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) interact with a region's industry mix, industrial structure, and institutions to determine the region's productivity. The following discussion summarizes the findings of earlier research regarding the roles of establishment age and churning, business size and competitiveness, business ownership structure, industrial diversity and specialization, and industry composition on regional economic development.[14]

<u>Establishment Age and Churning.</u> Young establishments in the New Economy tend to develop away from the manufacturing hubs of the old economy (Audretsch, 2002; Markusen 1991, 1996; Martin and Sunley, 1998). The infrastructural and institutional needs of the New Economy differ from those of the past. Regions built around the manufacturing economy appear unable to respond rapidly to changing infrastructural

requirements. Consequently, regions with younger establishments also are more likely to have high-tech manufacturing and service industries. Additionally, young firms exhibit higher productivity levels and gains than more mature firms, and young firms have high employment growth rates (Davis et al., 2008; Steinle, 1992). Meanwhile, absent competition from young firms, older firms are less innovative. Not only firms, but the industry and the region, are likely to progress through the product or profit cycle to eventual decline.[15] Consequently, business churning (what Schumpeter [1942] calls creative destruction) results in the birth of new firms in new industries and the death of older, less productive business.

<u>Business Size and Competitiveness.</u> Regions attract and retain firms through what Storper (1997) calls untraded interdependencies and other authors call agglomeration economies (Camagni, 2002a). Greater employment density is associated with greater growth potential. Shaffer (2002) finds a negative relationship between the average size of manufacturing and retail firms and the growth of median household income. Steinle (1992) also finds that economic growth is stronger when regional employment is dispersed among many smaller firms rather than concentrated in a few large firms. When more jobs are available, workers are more likely to find jobs that fit their skills and preferences (Scorsone, 2002). Similarly, firms are able to hire candidates with more appropriate skills. Search costs for both firms and employees are decreased, resulting in lower production costs (Dumais et al., 1997; Henderson, 1986).[16]

The presence of more firms provides employees with more options and increases the likelihood of finding a job for a spouse. These non-monetary benefits allow employees to accept a lower wage (Kim et al., 2000; Krugman, 1991). Firms must compete in both labor and product markets, and they benefit from lower labor supply prices. At the same time, a large labor pool demands goods and services, thus allowing firms to produce and distribute specialized goods with economies of scale (Greene et al., 2007). Finally, firms may benefit from the sharing of ideas and technology as employees form social networks across firms and industries (Carlino et al., 2006). A large number of professional and technical employees also increases the likelihood of new firm spin-offs (Kim et al., 2000).

Ownership Structure of Local Businesses. Markusen (1996) notes that there are several types of industry clusters and that cluster types differ in their stability and potential for growth. Traditional Marshallian (1920) clusters are made up of several small and medium-sized locally owned firms, and these local clusters foster the strongest economic linkages. Marshallian clusters demonstrate a greater amount of inter-firm collaboration and cooperation than other cluster types. Marshallian clusters generate strong institutional support, and local business owners are more likely than other mangers to be involved in regional organizations. Local business owners are also more likely to purchase supplies from local vendors and to spend profits locally, thus decreasing leakages from the regional economy (Barkley, 2001; Markusen, 1996).[17]

Satellite platform districts are composed of the branch plants of large, externally owned firms, and these plants engage in minimal trade and communication with other regional firms (Markusen, 1996; Smith and Barkley, 1991). The inputs of branch plants often are imported from other regions, and the plants' profits are sent to headquarters' locations outside the region. The success of branch plant clusters tends to hinge on the region's ability to recruit and retain branch plants. Hub-and-spoke clusters are made up of one or several large, vertically integrated firms and their network of suppliers. Inter-firm cooperation is limited to buy and sell relationships on the terms of the large firms. The growth of hub-and-spoke clusters depends on the large firms' growth. Finally, state-anchored clusters are dominated by one or more large government institutions (e.g., military bases and public universities), and they exhibit weak intraregional trade and communication other than with dominant suppliers. The success of state-anchored clusters is dependent upon the region's ability to maintain support for public facilities (Markusen, 1996). [18]

Definition and Role of Industrial Diversity. One of the most common industry structure/legacy measures is industrial diversity. Nissan and Carter (2006, p. 195) define industrial diversification as "…a measure of the extent of the distribution of employment among assorted industries that are different in nature." Malizia and Ke (1993, p. 222) define diversity as "…the variety of economic activity which reflects differences in economic structure." The Malizia and Ke definition recognizes that a region's industrial mix is tied to its transportation system, racial mix, and education level. Consequently, the industrial mix both reflects and influences the overall regional economy and culture.

Attaran and Zwick (1987) credit McLaughlin (1930) with producing the first index of industrial diversity. The post-World War I depression of 1921-1922 stimulated an interest in industrial diversity that intensified in response to the Great Depression of the 1930s (Attaran and Zwick, 1987; Mack, 2007; McLaughlin, 1930). More diversified economies are believed to be less susceptible to business cycles because different industries experience different cycles (McLaughlin, 1930). A broad industrial base protects regional economies during downturns in individual sectors, and therefore diversity stabilizes the economy. Malecki (2004) and the Corporation for Enterprise Development (2003) note that economic diversity ensures that a region can continue to grow even if any of its industries face a changing or declining market.[19]

Industrial diversity also promotes economic growth by providing urbanization economies (also called economies of scope). Economies of scope are similar to economies of scale but result from an agglomeration of general economic activity rather than from activity in one industry (Parr, 2002). Cities provide large pools of demand that allow for the specialization of products (Greene et al., 2007; Venables, 2006). They also provide a critical mass of resources and activity to decrease input acquisition costs, provide specialized public and private services, improve firm-labor matches, and facilitate the spread of new ideas (Barkley and Henry, 2001). Urbanization economies also arise from the trading of ideas across industries. For example, Feldman and Audretsch (1996) find that scientists cluster around a common scientific base, but a diversity of industries within that base promotes greater innovation.

<u>Clusters: Counterpoint to Diversity.</u> Porter (1990, 1998b) argues that economic growth results from industry clusters and specialization rather than diversification. Porter (1998b, p. 78) defines clusters as "…geographic concentrations of interconnected companies and institutions in a particular field." Specialization provides localization economies (also called external economies of scale) to firms and enables firms to make

use of both forward and backward supply linkages. A group of firms with common interests can benefit from formal and informal information networks and can work together to influence local institutions. Clusters form across related industries to take advantage of labor pools and new concepts and technologies as well as to facilitate supply chains (Dissart, 2003; Porter, 1998b). Clusters are highly attractive to the most skill-intensive industries and activities (Leamer and Storper, 2001; Venables , 1996).

In the knowledge economy, firms are increasingly dependent upon skilled labor, on devices that allow fast assessment and transcoding of information, and on coordination and cooperation both with other firms and with governments (Camagni, 1999). Cooperation and cumulative learning processes enhance the innovation and competitiveness of regional firms. Under economic uncertainty and complexity, in which decisions by one party affect many others, local milieux provide common values and codes and a sense of belonging and trust. These milieux facilitate the transcoding and evaluation of external information, the ex-ante coordination of private decisions to promote collective action, and an infrastructure for cumulative learning in the local labor market (Camagni, 2002a, 2002b). Firms in local milieux both cooperate and compete, building their own comparative and competitive advantages and creating a basis for local increasing returns. Cooperation with local governments and organizations enhances firm competitiveness. The merging of human and social capital, local institutions, and firm productivity provides justification for the concept of regional competitiveness (Camagni, 2002a). Unfortunately, the quality of institutions and social capital is difficult to measure.[20]

Industrial Diversity vs. Specialization. There is much debate about whether economies of scope or economies of scale are more important to regional economic growth.[21] Henderson et al. (1995) find that urbanization economies are more important to younger firms and industries while localization economies are more important to mature firms and industries. This suggests that younger industries benefit from the availability of general services and the flow of ideas between industries. More mature industries benefit from the communication networks and the agglomeration of services that build over time to meet the needs specific to that industry.

Dissart (2003) also attempts to reconcile the effects of industrial diversity and specialization on economic growth and stability. Dissart (2003, p. 438) coins the term "diversified specializations" to refer to the development of multiple clusters in a single geographic area. Dissart finds that employment stability results from diversity only if workers can transfer from one industry to another. Clusters facilitate labor transferability, especially as industries increasingly demand specialized skills. Likewise, Dissart attributes income stability to diversity, and he associates employment growth with specialization. Dissart is not able to determine whether economic diversity or specialization drives income growth.

Porter (2002) also recommends that regions focus on a broad array of clusters with overlapping skill and technology requirements to provide stable economic growth. Not all clusters are equal; industries with high value-added measures and high wages lead to stronger economic growth (Porter, 1990, 1998b).[22]

Industrial Composition. Industrial composition or mix is an important component of regional development in many economic growth theories (Donegan et al., 2008). Porter (1990, 1998b) admits that not all industry clusters provide equal economic benefits. Some clusters and industries have higher levels of productivity and innovation, and these industries pay higher wages and export their products (Porter, 2002). Wages in these traded industries may be driven up by strong complementarities between labor and other local resources (e.g., human capital in the biotechnology or information technology industries). Alternatively, industries may benefit from access to larger markets due to internet sales and low transportation costs (e.g., computers and pharmaceuticals).

Porter (2002) claims that the average wage in a region's traded industries has a greater effect on regional prosperity than does the industry mix.[23] Wages within industries are often a function of the innovativeness applied to that industry. As industries move through their product or profit cycles, production becomes standardized and requires fewer skilled workers (Markusen, 1985). The presence of high-wage firms in an industry indicates an earlier stage of the profit cycle, greater growth potential, and increased economic opportunities for the region's residents (Markusen, 1985; Porter, 2002).

In summary, Greene et al. (2007) propose that regional competitiveness is a real phenomenon. Greene et al. (2007) acknowledge arguments for path dependence, demand and supply factors, and simple luck in regional economic development, but they remain convinced that firms and regions do produce a synergy that affects regional success. They caution that regions are concerned about both social and economic goals, and the factors defining regional competitiveness are different from those of firm competitiveness. Consequently, researchers should clearly state what they mean by competitiveness when undertaking and writing about studies, and they should provide a reasoned justification for their definitions and models.[24]

## Benefits and Drawbacks to a Regional Competitiveness Strategy

### *Benefits of Regional Competitiveness*

The sheer volume of studies of competitiveness and its measurement indicate that many people find the concept beneficial to economic development efforts. Interest is not confined to academic circles; policymakers and the media are at least as interested in competitiveness as are academics (Bristow, 2005; Fisher, 2005). Bristow hypothesizes that part of the allure of measurements of competitiveness is that they allow policymakers to identify policy agendas from a fairly structured set of ideas, and these assumptions provide a sense of certainty. Competitiveness includes many factors policymakers can affect (Malecki, 2004), and competitiveness can also promote a regional identity and a common sense of purpose (Bristow, 2005).

Malecki (2004) and Camagni (2002b) note the positive-sum possibilities of promoting competitiveness based on local synergies and increasing returns. Increases in firm interactions, quality of life, and efficiency of public services benefit both local economies and social activities (Kitson et al., 2004; Malecki, 2004). Moreover, regional competitiveness policies can help improve the local technology base through increases in technological capacity, foresight, and innovation (Malecki, 2004).

*Drawbacks of Regional Competitiveness*

Competitiveness is not without drawbacks, many of which can be traced to disagreements about its definition and confusion regarding the new and old styles of competition (Budd and Hirmis, 2004; Kitson et al., 2004; Malecki, 2004). To Dunning et al. (1998), competitiveness is only the language of benchmarking. They argue that competitiveness, like benchmarking studies, identifies lagging areas but not the reasons for slow growth. Dunning et al. essentially define competitiveness as the level and growth of GDP per capita, and this Porter-type definition arguably does little to reflect outcomes of competitiveness or regional quality of life.

Malecki (2004, p. 1104) sometimes uses competition to refer to "low road" policies of smokestack chasing based on "low wages, docile labour, and low taxes." Alternatively, he refers to competitiveness as "competition on the high road" (p. 1108) based on promoting knowledge and innovation. Other times, however, he uses competition and competitiveness interchangeably, which confuses his criticisms of competitiveness. Malecki (2004, p. 1112) recognizes low wages and low taxes as the basis for the "old style of competition, embodied in subsidies, incentives and low road policies." Clearly, these attributes do not guarantee a high quality of life for residents. However, Malecki identifies two principal concerns that may be associated with either new or old styles of competition: the reduced likelihood of regional cooperation toward common goals and the zero-sum nature of place promotion and marketing.

Boschma (2004) notes that the imitation of one region's successful practices may be detrimental to another region with a different economic structure. Competitiveness relies on human and social capital factors that “are rare and not all ubiquitous” (Camagni, 2002b, p. 88), implying that regions do not compete equally (Camagni, 2002b; Malecki, 2004). Cheshire and Gordon (1998) find that many competitiveness policies, particularly those that are diversionary rather than capacity-building are wasteful spending. For example, improving amenities and attracting skilled labor can result in the same displacement and gentrification associated with traditional urban development, resulting in persistent or increased inequality (Asheim and Clark, 2001; Malecki, 2004).

Greene et al. (2007) admit that there are limits to policymakers’ ability to turn around lagging regions. Tacit knowledge and communities of practice are considered imperative to competitiveness in the New Economy. Greene et al. do not see how policymakers can readily impact knowledge processing and dissemination. Furthermore, policymakers do not share the risks and incentives of identifying the most productive firms and have not proven adept at “picking winners” (Bennett, 1996; Greene et al., 2007). Perhaps more troubling than the limited effectiveness of policymakers in improving competitiveness is the idea that cities may see a benefit to being perceived as a persistently lagging region. Some lagging regions may come to define success as securing ever larger subsidies to provide ever fewer public benefits. Such a response would transform positive-sum competitiveness into a zero-sum competition (Greene et al., 2007).

Bristow (2005) argues that the concept of competitiveness is too narrow in its view of how firms lead regions in competing in global markets and in securing prosperity for residents. The focus on regional competitiveness ignores the effects that national and global forces exert on regions, and it overlooks other means of achieving regional prosperity, such as the cultivation of inter-regional networks and the development of enterprises serving local markets or social causes (Bristow, 2005). Finally, much of the work in the field of competitiveness downplays the non-tradable aspects of regional development, including regional institutions, largely because of measurement difficulties.

**Benchmarking Regional Competitiveness**

*Overview of Benchmarking Practices*

Studies benchmarking, grading, and ranking regional competitiveness are increasingly common in both the academic literature and the popular press. Bristow (2005) attributes the proliferation of indices to the popularity of competitiveness as a key concept of economic development. Policymakers and economic development practitioners and researchers want to measure and compare regions' competitive performances to identify successful economies and winning development strategies.

Examples of benchmarking studies include the state and metropolitan *New Economy* indices (Atkinson, 2002; Atkinson and Gottlieb, 2001; Atkinson and Correa, 2007), the Milken Institute's *Best Performing Cities* (Devol et al., 2007), and *Money Magazine's Best Places* (*Money Magazine*, 2008) indices. Some indices target a specific type of economic activity, such as growth in the high-tech or knowledge sectors, often called the "New Economy" activities. For example, the five economic dimensions of *The State New Economy Index* (Atkinson, 2002) and *The Metropolitan New Economy Index* (Atkinson and Gottlieb, 2001) include knowledge jobs, globalization, economic dynamism, digital economy, and innovation capacity. Many of these publications assess cities', regions' or states' competitiveness based on measures of inputs or resources available (e.g., labor force quality, innovation, and entrepreneurship) while other studies focus on the outputs or outcomes of the competitiveness process (e.g., jobs and income).

The State Science and Technology Institute (SSTI, 2002) identifies seven indicators common among indices in the US: education, workforce composition, business environment, research and development (R&D) funding, venture capital, connectivity, and quality of life. Malecki (2004) provides examples of indicators used to measure economic performance in several innovation-driven indices (Innovation Philadelphia, 2002; Joint Venture, 2003; Petty, 2002). The categories range from the straight-forward (e.g., knowledge, capital, and location) to the less quantifiable (e.g., inclusive society, regional stewardship, regional personality, and inspiration).

The Great Depression is often credited with stimulating interest in indices of place in an effort to research optimal industry compositions and to minimize the effects of business fluctuations on regional economies (Atkinson and Court, 1998; Attaran and Zwick, 1987; Mack et al., 2007). However, examples of place indices can be traced back to the post-World War I depression of 1921-1922 (McLaughlin, 1930). Early indices typically included only measures of a region's business climate, such as industrial diversity. More modern indices of regional competitiveness also include quality of life measures such as regional amenities, education levels, personal income, and housing conditions (CFED, 2004; Eberts et al., 2006; and Gardiner, 2003). Fisher (2005) dates competitiveness indices back to the 1970s when states were fiercely competing over firms' locations. Atkinson (1990) pinpoints the origin of business climate studies to a 1975 study commissioned by the Illinois Manufacturing Association.

*Examples of Competitiveness Indices*

The following three examples of competitiveness indices describe various ways researchers create data sets that are comparable across places, weight the selected variables, and aggregate data into index scores. The studies detailed include a range of variables and indicators that address the policy and descriptive goals of each study. The examples point to the importance of careful consideration of the index inputs and construction and the need to be able to defend the indicators and methodology selected. Descriptions of additional indices are provided in Appendix B.

<u>The 2007 State New Economy Index and Precursors.</u> *The 2007 State New Economy Index* by Atkinson and Correa (2007) is an update of the Progressive Policy Institute's 1999 and 2002 state indices (Atkinson, 2002; Atkinson et al., 1999) that build on an earlier study of the US economy (Atkinson and Court, 1998). Atkinson and Gottlieb (2001) also present an index for metropolitan areas, and each index includes policy recommendations and suggested economic development strategies.

*The New Economy Index* (Atkinson and Court, 1998) collects public and private data to examine the key characteristics of the New Economy in the US. Atkinson and Court (1998, p. 8) define the New Economy as "a knowledge and idea-based economy where the keys to job creation and higher standards of living are innovative ideas and technology embedded in services and manufactured products. It is an economy where risk, uncertainty, and constant change are the rule, rather than the exception." Atkinson and Court divide 39 national indicators into three groupings representing (1) what's new about the New Economy, (2) New Economy outcomes, and (3) foundations for future growth. The first grouping is further divided into four categories: industrial and occupational change, globalization, dynamism and competition, and the information technology (IT) revolution. Outcomes are not further categorized within the second grouping. The third grouping includes categories for progress toward digital transformation, investment in innovation, and fostering New Economy skills. The index does not aggregate the indicators but simply tracks the levels of each indicator over time, beginning in 1960.

*The 1999 State New Economy Index* (Atkinson et al., 1999) uses 17 indicators to measure US states' progress in adapting to the New Economy. Atkinson et al. explain that state-level data on New Economy activities are harder to obtain than are national data. These indicators are divided into five sub-indices representing knowledge jobs, globalization, economic dynamism and competition, the transformation to a digital economy, and technological innovation capacity. Dividing data by the number of workers or gross state product controls for each state's size and allows scores to be compared across states. Scores for each indicator and resulting rankings are calculated based on standard deviations from the national mean. Because approximately half of the states have negative scores on any indicator, six is added to every score to make all values positive. Closely correlated indicators (e.g. patents, R&D spending, and high-tech workers) are weighted to avoid biasing the results.[25] Overall index scores are calculated by summing each state's adjusted scores in all of the five sub-indices and then dividing that value by the sum of the highest score achieved by any state in each category. Thus, each state's index score is a percentage of the score a state would receive if it ranked first in every category. Atkinson et al. divide the states into quartiles by dividing the range of the high and low scores by four. That quotient is subtracted from the highest score to identify the top quartile. Therefore, each quartile does not contain a fourth of the states, but rather it indicates a range of scores.

Atkinson (2002) updates the state-level index with *The 2002 State New Economy Index*. The 2002 index includes most of the indicators used in the 1999 report as well as additional indicators to measure IT adoption across all economic sectors, not just high-tech industries. For example, internet use by farmers and manufacturers is included. The 2002 index also includes a measure of the states' high-speed broadband communications infrastructure and an industry mix component. Atkinson's 21 indicators are grouped into the same five sub-indices, weighted, and summed as for the 1999 index. However, ten rather than six is added to the scores to achieve positive values. Because different indicators and weights are used in the two indices, scores cannot be compared over time.

Atkinson and Correa's *The 2007 State New Economy Index* (2007) is the most recent update of the index series. It is released by the Ewing Marion Kauffman Foundation and The Information Technology & Innovation Foundation and not the Progressive Policy Institute that published previous indices. The sub-indices are similar to those used in past years: knowledge jobs, globalization, economic dynamism, transformation to a digital economy, and technological innovation capacity, but 25 variables are included in those sub-indices. Many of the eight additional indicators take advantage of newly available data. Indicators added to the 2007 index include the number of entrepreneurs starting new companies, the number of patents issued to independent inventors, service industry exports, and employment in value-added manufacturing and high-wage traded service industries. Indicator scores are calculated as for the 2002 index. In 2007, indicators are weighted both to avoid correlation bias and according to their relative importance.[26] Sub-indices, indicators, and weights are shown in Table 2.1. Overall scores and quartiles are calculated using the prior years' methodology. The states' 2007 scores cannot be compared to past years' scores because the 2007 indicators and weights are somewhat different from those used in prior years.

*The Metropolitan New Economy Index* (Atkinson and Gottlieb, 2001) contains 16 indicators in the five sub-indices used in the 1999 and 2002 state-level indices. Data for the 50 largest consolidated metropolitan statistical areas (CMSAs) are adjusted to control for city size. Where data are missing or incomplete for a CMSA, scores are estimated based on proxy measures. These scores based on proxies are designated in the study's results. Indicator scores are constructed based on standard deviations from the mean for the 50 CMSAs. In three of the five sub-indices, closely correlated indicators are weighted to avoid correlation bias. The sub-indices are summed, and 20 is added to the sum of each CMSA's indicator scores to generate positive index values. The adjusted score is then divided by the sum of the highest scores attained in each category to form the overall index score for each city.

Table 2.1. Categories, Component Indicators, and Weights Used by Atkinson and Correa (2007).

| Category | Weight | Indicator | Weight |
|---|---|---|---|
| Knowledge jobs | 4.50 | Information technology jobs | 0.75 |
| | | Managerial, professional, and technical jobs | 0.75 |
| | | Workforce education | 1.00 |
| | | Immigration of knowledge workers | 0.50 |
| | | Manufacturing value-added | 0.75 |
| | | High-wage traded services | 0.75 |
| Globalization | 2.50 | Export focus of manufacturing and services | 1.00 |
| | | Foreign direct investment (FDI) | 1.00 |
| | | Package exports | 0.50 |
| Economic dynamism | 4.25 | "Gazelle" jobs | 1.00 |
| | | Job churning | 0.70 |
| | | Fastest growing firms | 0.50 |
| | | Initial public offerings (IPOs) | 0.75 |
| | | Entrepreneurial activity | 0.75 |
| | | Inventor patents | 0.50 |
| Digital economy | 3.85 | Online population | 0.75 |
| | | Internet domain names | 0.60 |
| | | Technology in schools | 0.50 |
| | | E-government | 0.50 |
| | | Online agriculture | 0.50 |
| | | Broadband telecommunications | 1.00 |
| Innovation capacity | 4.00 | High-tech jobs | 0.75 |
| | | Scientists and engineers | 0.75 |
| | | Patents | 0.75 |
| | | Industry investment in R&D | 1.00 |
| | | Venture capital | 0.75 |

The Dashboard of Indicators for the Northeast Ohio Economy. *The Dashboard of Indicators for the Northeast Ohio Economy* by the Upjohn Institute and Kleinhenz & Associates (Eberts et al., 2006) includes four measures of metropolitan economic growth: *gross regional output* is their measure of the overall economic activity of a region; *employment* is used as a measure of the opportunities for residents and migrants to earn wages and pursue careers; *productivity* (output per worker) is used to capture Porter's (1998) measure of competitiveness; and *per capita income* is a proxy variable for the local standard of living. Eberts et al. identify 40 input variables hypothesized to affect regional economic growth and collect variable data for 118 metropolitan areas similar in size to the metropolitan areas of Northeast Ohio.[27] The researchers study the 10-year period from 1994 to 2004 that approximately covers a business cycle and overcomes the effects of short-term disturbances or interventions.

Factor analysis is used to combine the 40 variables into eight independent factors. The factors contain statistically related variables, and they capture 90 percent of the variation in the 40 variables. Each variable is assigned to the factor upon which it has the largest effect in absolute value. The factor loadings are the correlation coefficients between the variables and the factors. Initial factor loadings are orthogonally rotated to maximize the variance of the squared factor loadings in order to make it easier to identify each variable as a component of a single factor. Only seven variables have such small factor loadings that they are excluded from the study. Gross change in employment due to business churning loads onto both the legacy of place and business dynamics factors. The variables contained in each of the eight factors are shown in Table 2.2. Because the factors have a near-normal distribution, regression coefficients estimate the effect of a one standard deviation change in a factor score on the percentage change in each growth measure. Together, the eight factors explain almost two-thirds of a region's growth in employment, output, and productivity and 46 percent of the growth in per capita income.

Eberts et al. rank the 118 metropolitan areas according to their scores for each of the eight factors. Eberts et al. find that a skilled labor force is the primary driver of economic growth. Skilled labor is the factor most highly correlated with output, per capita income, and productivity.[28] The business dynamics factor has the strongest positive association with employment growth. Eberts et al. show that in addition to economic factors, social values such as racial inclusion and income equality also positively impact the economic growth of metropolitan areas. The researchers find that locational amenities are positively correlated to growth, but amenities are less important than other factors in the index. Eberts et al. also find that growth is inhibited by legacy costs resulting from aging infrastructure and an unpopular climate. Legacy costs are most detrimental to regional output and employment. In summary, the study finds that the factors vary in importance depending on the outcome measured (growth in output, employment, productivity, or per capita income).

Austrian et al. (2007) update the *Dashboard Indicators* for 2007, and they expand the study area to 136 MSAs, 36 variables, and nine factors. Austrian et al. combine the racial inclusion and income inequality factors into one factor, and they add two additional factors: individual entrepreneurship and technology commercialization. Seven variables are added to the 2007 study: venture capital per employee, SBIR and STTR[29] awards per

Table 2.2. Factors and Component Variables Used by Eberts et al. (2006).

| Factors | Variables |
|---|---|
| Skilled workforce | Productivity in information sector<br>Number of patents per employee<br>Graduate degrees<br>Bachelor's degrees<br>Skill differences<br>Percent jobs in professional occupations<br>Percent of population between 16 and 64 |
| Urban assimilation | Percent Asian<br>Percent minority business employment<br>Percent foreign born<br>Percent homeownership<br>Commuter time<br>Cost-of-living index<br>Percent Hispanic |
| Racial inclusion | Percent Black<br>Isolation index<br>Dissimilarity index |
| Legacy of place | Number of governmental units<br>Climate index<br>Gross change in employment due to business churning<br>Crime index<br>Percent of houses built before 1940 |
| Income equality | Ratio of income of top 10 percent to bottom 10 percent<br>Percent of children living in high-poverty neighborhoods |
| Locational amenities | Major university presence<br>Transportation index<br>Arts index<br>Health index<br>Recreation index |
| Business dynamics | Percent of businesses employing fewer than 20 workers<br>Gross change in employment due to business churning<br>Concentration in manufacturing employment |
| Urbanization/metro structure | Percent of metro population in core city<br>Concentration of poverty in core city |

employee, industry R&D per employee, university R&D per employee, the percent of the workforce that is self-employed, the openings and closings of single establishments, and the property crime rate. Three variables are dropped between the 2006 and 2007 indices: commuting time, the presence of a major university, and the composite measure of education and labor skills. The same methodology is followed in 2006 and 2007, though five variables are obtained from a different source.

In addition to variable and factor changes, several variables load onto different factors in the 2006 and 2007 indices. Austrian et al. also use different MSA definitions based on US Office of Management and Budget updates to MSA boundaries (OMB, 2003). Nevertheless, Austrian et al. compare scores and changes in rankings between the two studies. When output measures are regressed on the factors, the $R^2$ measure for per capita income, employment, and gross regional output are similar in 2006 and 2007. The $R^2$ measure for productivity falls from 0.62 in 2006 to 0.22 in 2007. No explanation is provided for this drop in the 2007 model's explanatory power.

State Competitiveness Report 2007. The Beacon Hill Institute's (BHI) *State Competitiveness Report 2007* (Tuerck, et al., 2007b) is the seventh annual state-level index published by the institute. The *Metro Area Competitiveness Report 2007* (Tuerck et al., 2008) is the sixth annual index of the 50 largest metropolitan statistical areas (MSAs). The state and metro indices use the same methodology. The state index includes 42 variables, and the metro index includes 38 variables. The variables for both indices are grouped into eight sub-indices: government and fiscal policies, security, infrastructure, human resources, technology, business incubation, openness, and environmental policy.

The authors admit that variables are assigned arbitrarily to categories. Variables and categories are shown in Table 2.3.

Each variable is normalized with a mean of five, a standard deviation of one, and range from 0 (worst) to 10 (best). Varying standard deviations would result in different implicit weights, so the standardization of the variables is a first step in ensuring that indicators are equally weighted. The normalized component variables are combined intothe eight sub-indices by simple averaging. This approach is described as "transparent" and "democratic" (Tuerck et al., 2008, p. 9). Next, sub-indices are normalized with a mean of five and standard deviation of one. The overall index of competitiveness for each state or MSA is the simple average of the standardized sub-indices. This overall index is again normalized to a mean of five and a standard deviation of one, and the 2007 index ranges from 2.57 to 7.14. Data are converted to a proportional basis to account for differences in state and MSA sizes, and income per capita is adjusted for cost of living differences.

The BHI indices compare states' and cities' rankings from year to year. For example, the 2007 state index notes that Montana increased its rank to 15$^{th}$ from 28$^{th}$ in the 2006 report (Tuerck, et al., 2007a) while Michigan fell from 34$^{th}$ to 41$^{st}$. The BHI methodology is static over time. Variables are also remarkably constant although there are some changes from year to year. Thirty-one of the 42 variables in the 2007 state index are included in the 2001 index (Haughton and Slobodyanyuk, 2001). The remaining variables are either similar to original variables or represent newly available data. A few variables change sub-indices, especially when a ninth sub-index is combined into the

Table 2.3. Sub-indices and Component Indicators Used by Tuerck et al. (2007b, 2008).

| Sub-index | Indicator | Index* |
|---|---|---|
| Government & fiscal policy | State and local taxes per capita/income per capita | |
| | Workers' compensation premium rates | |
| | Bond rating | |
| | State bond rating | M |
| | Budget surplus as % of gross state product (GSP) | S |
| | Average benefit per first payment for unemployed | |
| | Full-time-equivalent state and local government employees per 100 residents | S |
| Security | Crime index per 100,000 inhabitants | |
| | Percent change in crime index, 2005-2006 | S |
| | Violent crimes per 100,000 inhabitants | M |
| | Thefts per 100,000 inhabitants | M |
| | Murders index per 100,000 inhabitants | |
| | The Better Government Association (BGA) Integrity Index | S |
| Infrastructure | Percent of households with installed phones | S |
| | High-speed lines per 1,000 | |
| | Air passengers per capita | |
| | Travel time to work | |
| | Electricity prices per million BTU | |
| | Median monthly housing costs | |
| Human resources | Percent of population without health insurance | |
| | Percent of population aged 25 and over that graduated from high school | |
| | Unemployment rate, not seasonally adjusted | |
| | Percent of students enrolled in degree-granting institutions | |
| | Percent of adults in the labor force | |
| | Infant mortality rate in deaths per 1,000 live births | |
| | Non-federal physicians per 100,000 inhabitants | |
| | Percent of public school fourth-graders at or above proficient in mathematics | S |
| Technology | Academic R&D per $1,000 GSP | |
| | National Institutes of Health (NIH) support to institutions in the state, per capita | |
| | Patents per 100,000 inhabitants | |
| | Science and engineering graduate students per 100,000 inhabitants | |
| | Science and engineering degrees awarded per 100,000 inhabitants | S |
| | Scientists and engineers as % of the labor force | |
| | Percent of total wage and salary jobs in high-tech industries | S |

Continued.

Table 2.3. Sub-indices and Component Indicators Used by Tuerck et al. (2007b, 2008), Continued.

| Sub-index | Indicator | Index* |
|---|---|---|
| Business incubation | Deposits in commercial banks and savings institutions, per capita | |
| | Venture capital available per capita | |
| | Employer firm births per 100,000 inhabitants | |
| | Entrepreneurial activity index | M |
| | Forbes Cost of Doing Business Index | M |
| | Initial pubic offerings as a share of GSP | S |
| | Percent of labor force that is represented by unions | |
| | Minimum wage | S |
| | New publicly traded companies | M |
| Openness | Exports per capita, $ | |
| | Incoming foreign direct investment (FDI) per capita, $ | S |
| | Percent of population born abroad | |
| Environmental policy | Toxic release inventory, pounds per 1,000 sq. miles | |
| | Carbon emission per 1,000 sq. miles | S |
| | Air quality index | M |
| | High ozone days, average | M |

*S=indicator in state index only; M=indicator in metro index only; unmarked indicators appear in both indices.

business incubation sub-index in 2004. However, BHI only comments on changes in rankings between adjacent years when the changes in the variables are small.

Comparison of the MSA rankings is more problematic. The MSAs included in the report vary as the 50 largest MSAs change over time due to population shifts and changes in US Census Bureau definitions. Additionally, the BHI uses only MSA data in 2007 as opposed to the CMSA data used for some areas in past years (Tuerck et al., 2008). This results in the addition of MSAs formerly included in larger CMSAs. For example, San Jose, California emerges from the San Francisco CMSA and is ranked 9$^{th}$ in the study. Changes in the definitions of MSAs compound the interpretation issues associated with the introduction of different variables over time.

*Benefits of Indices*

The State Science & Technology Institute (SSTI, 2002) lists several benefits of indices. Indices can develop the public's awareness of the current economic conditions and the need for change. Indices are concise and easy to understand, and they consolidate a large amount of information into a single value that can be compared across regions or over time. Indices can identify the aspects of the economy that need the most immediate attention and facilitate appropriate targeting of policies and programs. Indices provide evidence for long-term economic planning, as opposed to short-term goals motivated by election cycles. Regional promotion authorities can use data from benchmarking studies to enhance branding and marketing materials. Finally, if benchmarking studies are performed regularly, they can be used to assess the direction of a region's economy.

McCann (2004) finds that policy makers and business leaders do pay attention to competitiveness indices and specifically focus policies on improving rankings. Fisher (2005) claims that newspapers and their readers "love" rankings. Fisher (2005) and Bristow (2005) attribute indices' popularity to the fact that they are simple, require few analytical skills on the part of the user, and are easy to write about in the popular press. McCann agrees that media narratives of the good life in good places resonate with audiences and that indices reinforce beliefs about how economic policy should be conducted.

Eberts et al. (2006) point out that economic growth is controlled by powerful market forces. Understanding what forces drive a local economy helps policymakers and economic planners to inventory the region's assets, plan a viable economic development strategy, and use market forces to the region's advantage. Because economic development is an ongoing process, indices provide a basis for continual policy discussion and assessment. The successes of other regions suggest possible development strategies to local economic planners.

*Drawbacks of Indices*

Indices are criticized on many grounds; however, variable selection and methodologies for adjusting and weighting variables are two principal concerns (Atkinson, 1990; Fisher, 2005). Many authors also question whether indices do a good job of predicting economic success because regions can have vastly different rankings in various studies (Atkinson, 1990; Dunning et al., 1998; Fisher, 2005; Greene et al., 2007). Proponents of indices claim that the differences in rankings across indices occur because studies measure different aspects of competitiveness; however, Fisher (2005) argues that the measured aspects of competitiveness should not strongly affect place rankings. Fisher believes rankings should be similar across studies because the measures of competitiveness are similar and tend to be highly correlated.

Methodological Issues. Among the earliest critiques of indices is Atkinson's (1990) critical review of the controversial Grant Thornton index (1987) as compared to other indices.[30] Atkinson attributes the differences in rankings to differences in the variables selected by each index and how they are measured. Atkinson finds that all of the studies he surveys omit too many important variables; meanwhile some variables are double or triple counted. Wages, for example, are measured directly and are also included in a value-added measure. Other measures, such as poverty and the number of working poor, are highly correlated, which essentially leads to the double counting of some aspects of competitiveness. In some cases, variables are ambiguous. For example, increasing spending on education raises a state's rank in the Grant Thornton index, but funding that spending with increased tax dollars lowers the state's rank. Variables are often weighted to reflect a typical firm, but the relative importance of factors differs between industries (Atkinson, 1990; Cortright & Mayer, 2004). Cortright and Mayer suggest using occupational data in addition to industry measures in constructing indices to reduce the bias that results from a focus on industry data.

Fisher (2005) critiques five indices of competitiveness (including the Beacon Hill Institute indices [Haughton and Sirin, 2004]) based on five questions.[31] The first question is "does the index include all of the relevant variables and only relevant variables" (p. 2).

The second question is "do the causal variables in fact measure what they claim to measure" (p. 2). The third questions is "how does the index deal with the problem of combining disparate measures into a single index number" (p. 2). The fourth question Fisher asks is "does the index do a good job of predicting why some states or cities grew more rapidly than others over some time period" (p. 3). These four questions raise the fifth broader question: "is there a 'right way' to measure what these indexes purport to measure" (p.3).

The five indices critiqued by Fisher (2005) produce very different rankings, which Fisher cites as evidence of their flaws. Fisher contends that if the rankings measure similar things, they should produce similar results. Overall, Fisher finds that the studies do not answer his questions well. They do not measure the right things to achieve their stated purposes, and they do not do a good job of measuring what they claim to measure. For example, without controlling for a state's industrial structure, measuring worker productivity by value-added per dollar of production payroll makes states with capital-intensive industries appear more productive.

Fisher finds that indices do a poor job of predicting a state's economic success because they neither measure the correct variables nor combine measures appropriately. For example, Fisher (2005, p. viii) describes the Beacon Hill Institute (BHI) indices as "a mishmash of causal and performance variables that render it useless as an overall predictor of anything." While BHI tests its indices based on their ability to predict per capita income, many of the BHI index measures are themselves outcomes rather than causes of growth. Consequently, many variables are correlates of income. For example, high infant mortality is a result of poverty, not a cause of it. Fisher finds other BHI variables questionable based on the assumptions of their use or ambiguous causality. The BHI also suffers from a large number of missing data points. Fisher questions whether the use of equal weights is appropriate as it gives variables in sub-indices with fewer indicators greater implicit weights. When an appropriate cost-of-living measure is applied to the data, Fisher finds that the BHI indices are not significant (at even the 10 percent level) in meeting their claims to predict per capita income and measure how well a region can compete for economic growth. In Fisher's opinion, poor predictive power combined with the mixture of causal and outcome variables render the BHI policy recommendations invalid.

Fisher (2005) notes that indices prepared by magazines catering to location consultants and managers have different variables and approaches than do indices prepared by policy institutes. In addition to studies using causal variables (that are the focus of his study), Fisher cites three magazine articles that measure only business outcomes.[32] He finds these outcome-based indices to be broader in scope than many studies by policy institutes that tend to focus on a narrow range of issues such as tax codes or labor laws. For example, the magazines' variables include energy costs, educational attainment, health care measures, and transportation measures. At the same time, Fisher finds that the magazine studies have fewer extraneous variables without theoretical justification. However, the popular press studies do not use academic standards of methodological transparency, and they are therefore harder to critically evaluate.

Eberts et al. (2006) also believe that the use of too many indicators of competitiveness can be confusing and misleading. They explain that indices are often collections of interesting and seemingly useful indicators with the idea that readers can pay attention to the indicators that are most interesting to them or best fit their goals. However, this approach ignores the question of whether the indicators have a meaningful relationship to the economy.

Hall (2007) notes that many indices' measures are not practically useful to policymakers, and he recommends balancing detail and brevity. Hall criticizes indices for failing to separate capacity from outcomes. Some indices succeed in classifying inputs and outputs, but they still mix them in indices (e.g. Devol et al., 2004). Hall claims that no indices distinguish innovation capacity from commercialization capacity, and he cites financial capital as a major distinguishing factor in deriving economic benefit from innovation.

Greene et al. (2007) examine 22 studies of urban competitiveness and find little evidence of a causal relationship between the measured variables and regional competitiveness. Greene et al. conclude that competitiveness is simply a function of correlation between the dimensions of competitiveness that are measured (e.g., regional per capita income and the percent of the regional employment in professional industries). Methodologically, most studies rely on data from government statistics offices; Greene et al. also acknowledge the problems associated with government statistics and the sizes and shapes of the defined regions.

Policy Concerns. Fisher (2005) cites Skoro (1988) in questioning whether indices are useful in developing regional economic development policies and strategies. Skoro hypothesizes that a useful business climate index must consist of measurable indicators that have substantial effects on economic outcomes and that are generic across industries, regions, and time. Fisher warns against the use of ideologically-based indices in policy analysis. Fisher notes that policy think tanks prepare their indices to influence public policy, and he claims that the ideological fit of the index becomes more important than its validity or reliability.[33]

Fisher seconds Atkinson (1990) in pointing out that many researchers have concluded that factors in location decisions are industry specific. Within the manufacturing industry, location may even be project specific because access to suppliers and markets is critical. Atkinson (1990) finds that problems with variable selection and methodologies mean that rankings need to be carefully examined before they are used to influence policy or location decisions. Atkinson's research showed that firms may use indices for initial comparisons of places, but firms do not base location decisions on a single index or even indices in general.

Boschma (2004) and McCann (2004) caution against using indices to compare regions on the grounds that each region has different strengths, and imitation of inappropriate policies can be a prescription for economic failure. Hall (2007) also criticizes indices for providing a snapshot of the present economic condition rather than examining the trends that resulted in that condition. Dunning et al. (1998) find that indices identify successful and lagging regions but fail to explain why these regions succeed or struggle. Bristow (2005) explains that lagging regions and their leaders may be stigmatized for deficiencies beyond their control. Bristow (2005) and Cortright and Mayer (2004) suggest that a focus on index rankings diverts attention away from the underlying roles of regional competitiveness determinants, such as investment and industry clustering.

Greene et al. (2007) find that indices confirm the obvious; cities and regions widely held to be successful rank highly. They conclude that benchmarking studies do not reduce inequality between places and may actually increase it. Furthermore, benchmarking studies provide little information about how people perceive their standard of living (Greene et al. 2007). Low income people tend to be more embedded in their communities, and social cohesion may have an inverse relationship to the economic factors often studied.

*Recommendations for Index Creation*

Despite his criticisms of business and manufacturing climate indices, Atkinson (1990) concludes that indices are popular and unlikely to disappear from the economic development toolbox. Greene et al. (2007, p. 16) are resigned to benchmarking as part of a "broader movement towards an audit culture…and a neo-liberal approach to economic governance in market economies." Fisher (2005) concludes his review of competitiveness indices by offering suggestions for index creation. These suggestions render his harsh critique not a condemnation of indices but an entreaty for better ones. Fisher's five questions offer some basic suggestions for index construction. Specifically, indices should include all of the relevant variables and only relevant variables; measure what they claim to measure; and do a good job of predicting economic growth. For example, Fisher insists outcome measures do not belong in a business climate index and are equivalent to measuring indicators of how well off an area already is and then telling regions if they increase these things, they will be better off (Fisher, 2005; Sims, 2003).

Indices more accurately identify competitive places when variables are uncorrelated and appropriately weighted. Fisher provides recommendations for combining indicators into a single index. Variables can be ranked, rescaled, or standardized. Variables may also be weighted prior to being summed or averaged to create the index. If sub-indices are used, the sub-indices also may be adjusted and weighted prior to inclusion in the overall index. Ranking, rescaling, or standardizing variables avoids the problem of larger absolute values dwarfing smaller values (e.g., venture capital dollars [a whole number] reducing the implicit contribution of the percent of workforce that are college graduates). Ranking, rescaling, or standardizing variables can reduce the influence of large and/or highly variant indicators in an index and also prevents high and low values from averaging out. Variable adjustment is a form of weighting, and standardization makes the weighting scheme more transparent than raw numbers or arbitrary weights.

Fisher opposes equally weighting variables on the grounds that all variables do not affect outputs or outcomes with equal magnitude. Variables should be given weights commensurate with their effects on measures of regional competitiveness. Regression analysis can be used to create weights for variables in an index, but the quality of the index now relies on the quality of the econometric analysis in terms of the appropriateness of the selected variables and model specification.

Scott and Lodge (1985) propose that the evaluation of competitiveness should consider both the present and the future in addition to measuring past performance. Researchers should identify and classify the forces that affect industries and regions, such as research, innovation, investment, employment, production, and trade decisions. Although Scott and Lodge regard the trade and current account balances as important factors of competitiveness, they believe that profitable maintenance of a target market share is also important. Furthermore, they remind readers that competitiveness is not an end in itself; it is a way to achieve a rising standard of living. As such, they recommend that researchers and policymakers measure regional competitiveness not just over time or relative to other regions but also relative to basic goals and commitments.

Many authors point out that a region's industrial history, diversity, and structure influence its competitiveness (Bristow, 2005; Dunning et al., 1998; Fisher, 2005; Greene et al., 2007; Porter, 2003b). Consequently, industrial legacy affects how the region responds to economic development policies and programs (Eberts et al., 2006; Kitson et al., 2004). However, few benchmarking studies account for industrial structure and diversity, and those studies that do have industrial legacy variables include them as inputs to the competitiveness process (Eberts, 2006; Gardiner 2003). This treatment of industrial structure and diversity variables as inputs is at odds with the literature that describes industrial legacy variables as environmental factors that interact with and influence policy-driven inputs.

**Summary**

This chapter reviews several definitions of regional competitiveness and describes the sources of competitive advantage (e.g., innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) and the environment for competitiveness (e.g., establishment age and churning, business size and competitiveness, industrial diversity and specialization, and industry composition). Three conceptual models of regional competitiveness are described, and the benefits and drawbacks of an economic development strategy based on competitiveness are discussed. Three studies that benchmark competitiveness are described in detail. The chapter concludes with a discussion of the benefits and drawbacks to indexing competitiveness and recommendations for improving benchmarking studies. Both methodological and policy concerns are acknowledged.

The following chapters build on earlier definitions and models of competitiveness to create a new index of regional competitiveness for metropolitan statistical areas in the Southern US Census region. The research presented in chapters three and four has two principal goals: (1) to determine appropriate variables and variable weights for benchmarking the growth in metropolitan population, employment, and per capita income, and (2) to incorporate regions' industrial legacies into metropolitan growth models and indices.

# CHAPTER 3

# DATA AND METHODS

## Introduction

The purpose of this study is to evaluate possible improvements to the construction of indices benchmarking regional economic competitiveness. This study contributes to the literature on regional benchmarking in two ways. First, variable weights are tested to see if inputs affect various economic outcomes (e.g., growth in population, employment, and per capita income) differently. Variables and variable groupings are expected to have different effects on the various outcomes. Second, interaction terms between input variables and industrial structure/diversity measures are included in growth models to determine whether a region's economic environment and industrial legacy influence the effectiveness of economic policies. For example, education initiatives may have different effects on regions with different economic histories. The significance of interactions between inputs and industrial legacy will suggest that policies may be location-specific or at least may not be equally applicable to all regions. Significant interaction terms also will indicate that researchers should not use similar variable weights for all regions in competitiveness indices.

The second section of this chapter describes economic growth models and the application of those models to index creation, and studies using these models are presented. The third section presents the conceptual and mathematical models used in this study. Section four describes the variables used in the study, their data sources, the years for which the data is available, and how missing data will be proxied. This section also describes the study area and how it is updated over the three years for which data are collected. Section five concludes the chapter with a brief summary of the methodology and a review of *ex ante* expectations.

## Economic Growth Models

Most economic growth models fall into the domain of neoclassical economics. Neoclassical growth models assume perfectly elastic demand and no supply constraints. In essence, they invoke Say's Law: supply creates its own demand (Say, 1855). Neoclassicists assume that factors of production (labor and capital) migrate to the regions where they have the highest rate of return. As a result, disparities in productivity growth and income are reduced and eliminated over time. Neoclassicists maintain that government intervention into markets creates inefficiencies and may do more harm than good. Newer variants of neoclassical economics, such as new growth theory, allow a greater role for governments in expanding economic growth (Malizia and Feser, 1999).

### *Overview of Regional Growth Models*

<u>Neoclassical (Solow) Growth Models.</u> Early neoclassical growth models explain short-term growth as a function of the capital-labor ratio. Both capital and labor face diminishing returns that are overcome in the long-run by technological progress. Consequently, the drivers of long-term growth are exogenous to the model. Solow (1956) models converge to a steady state equilibrium. Output (or income), $Y$, is a function of capital ($K$), labor ($L$), and cumulative exogenous technology, ($A(t)$):

$Y = A(t)F(K,L)$. (3.1)

The above equation models neutral technological change. The technology term, which includes knowledge, acts equally on both capital and labor. Other specifications of the model allow technology to act on capital alone or labor alone. The model is solved by taking derivatives with respect to time, which are denoted by a dot over the variable:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + A\frac{\partial F}{\partial K}\frac{\dot{K}}{Y} + A\frac{\partial F}{\partial L}\frac{\dot{L}}{Y}. \quad (3.2)$$

The percentage change in output decreases over time until a steady state is reached (Solow, 1957). The model predicts the steady-state amounts of capital and labor in addition to the steady-state output. The Solow model predicts convergence across regions as small countries catch up to large countries that attempt to increase already large outputs.

Lucas Model. Despite efforts to account for human capital in the 1960's, Lucas (1988) and Romer (1986, 1990) are credited with making human capital endogenous to growth models. Human capital, usually measured by years of schooling, can be applied to growth models in various ways. Lucas essentially uses the Cobb-Douglas form of Solow's growth model, but he augments labor with human capital, *h*:

$Y = AK^{\alpha}(uhL)^{1-\alpha}$. (4.3)

In the aggregate version of Lucas' model, the *u* term stands for the proportion of the working population engaged in production of goods and services, and *1-u* is the proportion of the labor force engaged in research and knowledge production. When per capita output is modeled, *u* is interpreted as the proportion of an individual's time spent working rather than studying. The $\alpha$ term is the elasticity of output with respect to capital. The output elasticities of capital and labor sum to one, indicating constant returns to scale.

Romer Model. Romer (1990) includes human capital as a third input in the Cobb-Douglas production function:

$$Y = H_Y^{\alpha} L^{\beta} \sum_{i=1}^{\infty} x_i^{1-\alpha-\beta} , \tag{3.4}$$

where $H_Y$, is human capital devoted to final output, $\alpha$ is the elasticity of output with respect to human capital, and $\beta$ is the elasticity of output with respect to labor. The sum of all inputs, $x_i$, is equivalent to physical capital. The Romer model also relies on constant returns to scale.

Mankiw, Romer, and Weil Model. Mankiw et al. (1992) separate technological progress, $A_{it}$, from human capital, $H_{it}$, in modeling output:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{1-\alpha-\beta}. \tag{3.5}$$

The $i$ subscript denotes the region and the $t$ subscript denotes the time period. Mankiw et al. rely on decreasing returns to all forms of capital to achieve a steady state.

Glaeser et al. Model. Glaeser et al. (1995) model the relationship between the characteristics of 203 large cities in 1960 and the growth of population and income in those cities from 1960 to 1990. Glaeser et al. build on previous models capturing the spillovers of physical capital and knowledge (Romer, 1986); human capital externalities (Lucas, 1988); and inter-industry technology transfers (Porter, 1990). Physical capital and labor are more mobile across city-regions than across national boundaries, so these factors move to the location with the highest return. Therefore, Glaeser et al. allow cities to differ only in their productivity levels and qualities of life.

The total output in city $i$ at time $t$ ($Y_{i,t}$) is a function of the city's level of productivity at time $t$ ($A_{i,t}$), the city's population at time $t$ ($L_{i,t}$), and a nation-wide production parameter, $\sigma$:

$$Y_{i,t} = A_{i,t} L_{i,t}^{\sigma} . \tag{3.6}$$

The first derivative of the production function provides the wage in city $i$. The total utility of a potential migrant to city $i$ is the city's wage multiplied by a quality of life index. The utility of a migrant to city $i$ is given by the function:

$$Utility = \sigma A_{i,t} Q_{i,t} L_{i,t}^{\sigma-\delta-1} \tag{3.7}$$

where $Q_{i,t}$ is the quality of life index, and $\delta$ reflects the assumption that quality of life is decreasing in population ($\delta > 0$).

Each dependent and independent variable in the utility equation is divided by the previous time period's value so all variables represent a ratio between time periods. The assumption of perfect mobility ensures constant utility across cities. The utility equation is logged and rearranged to solve for the growth in population and wages:

$$(1+\delta-\sigma)\ln\left(\frac{L_{i,t+1}}{L_{i,t}}\right) = \ln\left(\frac{A_{i,t+1}}{A_{i,t}}\right) + \ln\left(\frac{Q_{i,t+1}}{Q_{i,t}}\right) \tag{3.8}$$

and

$$\ln\left(\frac{W_{i,t+1}}{W_{i,t}}\right) = \delta \ln\left(\frac{L_{i,t+1}}{L_{i,t}}\right) - \ln\left(\frac{Q_{i,t+1}}{Q_{i,t}}\right). \tag{3.9}$$

The growth in population and wages can also be expressed as a function of variables expected to affect productivity ($\beta X_{i,t}$) and variables thought to influence quality of life ($\theta X_{i,t}$):

$$\ln\left(\frac{L_{i,t+1}}{L_{i,t}}\right) = \frac{1}{1+\delta-\sigma} X'_{i,t}(\beta+\theta) + \chi_{i,t+1} \tag{3.10}$$

and

$$\ln\left(\frac{W_{i,t+1}}{W_{i,t}}\right) = \frac{1}{1+\delta-\sigma} X'_{i,t}(\delta\beta+\sigma\theta-\theta) + \varpi_{i,t+1}, \tag{3.11}$$

where $\chi_{i,t+1}$ and $\varpi_{i,t+1}$ are error terms.

Glaeser et al. (1995) regress each city's population growth and per capita income growth between 1960 and 1990 on variables representing the city's population, income, migration, geography, racial composition, labor force, education, income inequality, and government characteristics in 1960. Glaeser et al. claim that population growth is a good primary measure of economic growth because it represents the extent to which cities are attractive places for people and businesses. Income growth is important because it reflects a region's standard of living. However, measurements of income growth are less straightforward because they capture both increases in productivity and decreases in quality of life.[34]

Glaeser et al. (1995) find little evidence of convergence among city populations. Cities that grew faster from 1950 to 1960 also grew faster from 1960 to 1990. Cities with higher percentages of initial employment in manufacturing industries grew slower than regions less dependent on manufacturing, indicating that industrial legacy is a significant determinant of growth. When Glaeser et al. control for education, they find evidence of income convergence.[35] They find that the percent of the population with high school diplomas or some college is more important than the percent with college degrees to income convergence. Glaeser et al. attribute city growth to high education levels, low unemployment, and low exposure to manufacturing industries. They believe that education influences the growth of technology and thus stimulates growth in population, employment, and income.[36]

Glaeser et al. find a weak negative relationship between city growth and the percent of nonwhite residents, but this relationship disappears when controls for unemployment, share of employment in manufacturing, and education are included in the regression. Therefore, Glaeser et al. conclude that race is correlated with the initial economic characteristics of cities. Government revenue and spending are not found to influence city growth in the Glaeser et al. study.

Carlino-Mills Model. Carlino and Mills (1987) use a simultaneous systems approach to study changes in regional population and employment in US counties. Their model simultaneously determines population and employment densities based on regional variations in agglomeration economies, comparative advantages, government actions, labor supplies, and transportation costs. The simultaneous model allows both people and firms to respond to economic conditions.

Carlino and Mills model county employment density as a function of county population density and a vector of exogenous variables, and they simultaneously model population density as a function of employment density and another vector of exogenous variables:

$$E^* = A_E P + B_E S \tag{3.12}$$

and

$$P^* = A_P E + B_P T\ , \tag{3.13}$$

where $E$ and $P$ are county employment and population density, and the asterisks indicate equilibrium values. The $S$ and $T$ terms represent vectors of exogenous variables that affect either employment or population. The $A_E$ and $A_P$ terms are coefficients on the endogenous variables in the simultaneous equations, and the $B_E$ and $B_P$ terms are vectors of coefficients on the $S$ and $T$ vectors, respectively.

Carlino and Mills incorporate the adjustments of county employment and population densities to their equilibrium values using a distributed lag term in each equation. Current employment and population densities adjust by a fraction ($\lambda$) of the difference between their equilibrium levels and their lagged values:

$$E_t = E_{t-1} + \lambda_E (E^* - E_{t-1}) \tag{3.14}$$

and

$$P_t = P_{t-1} + \lambda_P (P^* - P_{t-1})\ . \tag{3.15}$$

Substituting Equations 3.12 and 3.13 into Equations 3.14 and 3.15 and rearranging terms yields:

$$E_t = \lambda_E A_E P_t + \lambda_E B_E S + (1 - \lambda_E) E_{t-1} \tag{3.16}$$

and

$$P_t = \lambda_P A_P E_t + \lambda_P B_P T + (1-\lambda_P) P_{t-1}. \quad (3.17)$$

In Equations 3.16 and 3.17, employment and population each depend on their own lagged values, the current value of the other endogenous variable, and on a set of exogenous variables.

Carlino and Mills use two-stage least squares (2SLS) regression to estimate regional population based on employment and employment based on population. They regress 1979 county employment density on its 1969 value, 1980 population, and a vector of exogenous variables using 2SLS. The exogenous variables include the percent of black residents in 1970; local government taxes per capita in 1972; median family income in 1970; the 1975 crime rate; median schooling in 1970; the value of industrial revenue bonds; and metropolitan, city center, and Census region dummies. Most of the exogenous variables are lagged to the starting period to reduce simultaneity and direction of causation issues. Similarly, 1980 population density is regressed on its 1970 value, 1979 employment, the percent of black residents, interstate highway density, median family income, the union membership rate, the value of industrial revenue bonds, and the city and regional dummies.[37]

The coefficients from the structural equations are used to calculate reduced form equations. The reduced form coefficients and the sample means of the variables are used to calculate elasticities for employment and population densities. Carlino and Mills find that population and employment have strong positive effects on each other.[38] They find that higher family incomes are strongly related to increases in both population density and employment density, as are interstate highway density and the level of development bonds. Unionization and high local taxes have negative relationships to both employment and population densities. The percent of black residents has a positive association with employment but a negative association with population.[39]

The results of estimations of growth rate and log specifications of the model also are provided. In the growth rate specification, the dependent variables are expressed as the percentage changes in employment and population densities between 1970 and 1980. The growth rate specification adds unity to the coefficient on the lagged term from the level model; all other coefficients are the same. The log form is derived from a multiplicative functional form of Equations 3.12 and 3.13 as opposed to the additive form used in the paper. The multiplicative form provides implausible empirical results.

Carruthers and Mulligan Model. Carruthers and Mulligan (2008) study metropolitan growth and change under an expanded Carlino-Mills framework.[40] Carruthers' and Mulligan's regional adjustment model simultaneously solves equations for population density ($p$), employment density ($e$), and average annual wage ($y$). Each dependent variable's rate of change is a function of its lagged or base year values, the current values of the other two endogenously determined variables, and a vector of initial conditions ($x_{i,t-1}$) including city size, industrial composition, human capital, and quality of life factors:

$$\frac{p_t}{p_{t-1}} = \alpha_0 + \alpha_1 p_{t-1} + \alpha_2 e_t + \alpha_3 y_t + \alpha_4 x_{p,t-1} + \varepsilon_{p,t}, \tag{3.18}$$

$$\frac{e_t}{e_{t-1}} = \beta_0 + \beta_1 p_t + \beta_2 e_{t-1} + \beta_3 y_t + \beta_4 x_{e,t-1} + \varepsilon_{e,t}, \tag{3.19}$$

and

$$\frac{y_t}{y_{t-1}} = \gamma_0 + \gamma_1 p + \gamma_2 e_{t-1} + \gamma_3 y_t + \gamma_4 x_{y,t-1} + \varepsilon_{y,t}, \tag{3.20}$$

where $p$ is population per square mile, $e$ is employment per square mile, and $y$ is average annual wage. Initial conditions in the $x$-vectors are expressed as location quotients. The $\alpha$, $\beta$, and $\gamma$ terms are estimation parameters, and the $\varepsilon_{i,t}$ are error terms.[41]

Carruthers and Mulligan estimate the natural logs of the rates of change in population, employment, and annual average wage. The endogenous variables are also logged on the right-hand side of the system of equations although the $x$ vector remains in level terms:

$$\ln\left(\frac{p_t}{p_{t-1}}\right) = \alpha_0 + \alpha_1 \ln p_{t-1} + \alpha_2 \ln e_t + \alpha_3 \ln y_t + \alpha_4 x_{p,t-1} + \varepsilon_{p,t}, \tag{3.21}$$

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \beta_0 + \beta_1 \ln p_t + \beta_2 \ln e_{t-1} + \beta_3 \ln y_t + \beta_4 x_{e,t-1} + \varepsilon_{e,t}, \tag{3.22}$$

and

$$\ln\left(\frac{y_t}{y_{t-1}}\right) = \gamma_0 + \gamma_1 \ln p + \gamma_2 \ln e_{t-1} + \gamma_3 \ln y_t + \gamma_4 x_{y,t-1} + \varepsilon_{y,t}. \tag{3.23}$$

Two-stage least squares (2SLS) regression of Equations 3.21 through 3.23 reveals that the rate of change in population density is negatively related to lagged population density, positively related to current employment density, and negatively related to current average wage. The rate of change in employment density is negatively associated with base year employment density and positively associated with current population density and average wage. The rate of change in average annual wage is negatively correlated with the lagged wage and current population density but positively correlated with current employment density.

Carruthers and Mulligan also find that the share of metropolitan earnings from the financial, insurance, and real estate sector is associated with increasingly positive metropolitan growth. Meanwhile, a large share of earnings from manufacturing is often associated with a negative rate of change in outcome measures. Concentrations of high school and college-educated populations are associated with higher rates of change for population and employment densities.

*Considerations in Estimating Changes in Regional Outcomes*

<u>Effects of Model Specifications.</u> The model specification determines how regional characteristics are perceived to affect aggregate production and growth. The constant-returns-to-scale Cobb-Douglas form is one popular specification; however, returns to scale are modeled as increasing or decreasing in other specifications. In addition, some studies model output as a function of maximum education, minimum education, or average education. These models have different implications for investment in education, and outcomes may be influenced by different human capital specifications. For example, average education may matter for some outcomes while the percent of the population with advanced degrees might be more strongly associated with other outcomes (Glaeser et al., 1995).

<u>Logged Equations.</u> Comparisons of growth rates across regions and time are made easier by the use of natural logs. Taking the logs of equations with exponential terms results in linear equations that are easier to manipulate and to estimate with regression

techniques. Coefficients in the logged equations represent as percent changes in the dependent variable resulting from a one percent change in an explanatory variable, holding all else constant. For example, the log of the Lucas (1988) Equation 3.3 is

$$\ln Y = \ln A + \alpha \ln K + (1-\alpha)\ln u + (1-\alpha)\ln h + (1-\alpha)\ln L. \quad (3.22)$$

The first differencing of equations captures the differences between two time periods. Variables that do not change between the periods are cancelled out in the differencing process. This allows static variables to be excluded from the regression without causing omitted variable bias. The first differencing of Equation 3.22 results in

$$\Delta\ln Y = \Delta\ln A + \alpha\Delta\ln K + (1-\alpha)\Delta\ln h + (1-\alpha)\Delta\ln L. \quad (3.23)$$

The $\Delta$ denotes the change in the variable over the time period. Thus, $\Delta lnY$ is the growth rate of output. Equation 3.23 can be estimated with linear regression techniques.

Per capita measures allow variables to be compared across regions with different population levels. Usually per capita measures are the ratio of the variable to the total population. However, the populations in a specified age group or the labor force are alternative denominators. The choice of the denominator is driven by the data. For example, college degrees are usually measured relative to the population older than age 25 because children and teenagers in the total population are not yet expected to have completed college. Employment is measured relative to the working age population or labor force to exclude children and retirees (Atkinson and Correa, 2007; Tuerck et al., 2008). Per capita variables are usually denoted by lower case letters. The per capita form of the first-differenced Equation 3.23 therefore would be

$$\Delta\ln y = \Delta\ln A + \alpha\Delta\ln k + (1-\alpha)\Delta\ln h + (1-\alpha)\Delta\ln l. \quad (3.24)$$

The $\Delta lny$ term in Equation 3.24 is interpreted as the percentage change in per capita income resulting from percentage changes in technology ($A$), per capita physical capital ($k$), human capital ($h$), and per capita labor ($l$).

Because of the properties of log functions, Equation 3.24 is equivalent to

$$\ln\left(\frac{y_t}{y_{t-1}}\right) = \ln\left(\frac{A_t}{A_{t-1}}\right) + \alpha\ln\left(\frac{k_t}{k_{t-1}}\right) + (1-\alpha)\ln\left(\frac{h_t}{h_{t-1}}\right) + (1-\alpha)\ln\left(\frac{1_t}{h_{t-1}}\right). \quad (3.25)$$

Here, the logs are expressed as ratios of current variables to variables from a past time period. The ratios represent growth in the per capita variables.

<u>Level Models.</u> A linear model without logarithms can also be estimated. This model is no longer equivalent to the Lucas model because it is the natural logs that convert Lucas' model from exponential form to linear form. However, the level model has the advantage of allowing the researcher to use measured values rather than logs. The level model estimates the value of per capita income resulting from the levels of the measured inputs. The level model is represented by

$$y = A + \alpha k + (1-\alpha)h + (1-\alpha)\ell \quad (3.26)$$

The level model can also estimate the actual change, as opposed to the percentage change, in per capita income due to actual changes in measured inputs. Level changes are expressed as

$$\Delta y = \Delta A + \alpha\Delta k + (1-\alpha)\Delta h + (1-\alpha)\Delta\ell. \quad (3.27)$$

The level model is more intuitive than the log-linear model when variables are already measured as percentages of benchmark values. In this case, $\Delta y$ is the percent change in regional per capita income relative to the percent change in the benchmark income (e.g., national income or average metropolitan income) resulting from the changes in relative inputs. Common benchmarks are national averages or averages of study regions.

Models with Standardized Variables. Some variables are measured on a scale that is difficult to interpret. For example, test scores are difficult to interpret because students are often graded relative to other students. A standardized variable represents the relationship of the variable's raw level to the population average. A variable is standardized by subtracting the variable's mean from each observation and dividing the difference by the variable's standard deviation. Standardized variables have a mean of zero and a standard deviation of one.

The interpretation of a standardized coefficient is the change in the dependent variable given a one standard deviation change in the standardized explanatory variable (Wooldridge, 2003). Glaeser et al. (1995) standardize median years of schooling across cities, so the estimated coefficient on schooling in their logged city population model is interpreted as the percent change in city population associated with a one standard deviation increase in a city's median years of schooling.

The coefficients on standardized variables can be compared more easily than coefficients on variables with different scales (e.g., people per square mile and dollars per person) because all variables are measured relative to their means, and all variables have the same standardized mean (zero) and standard deviation (one) (Wooldridge, 2003). Standard deviation also facilitates the combination of variables into composite measures, again because all variables have the same mean and standard deviation (Kim and Mueller, 1978).

## Theoretical Model for Estimating the Determinants of Competitiveness

This study explicitly combines a conceptual framework for regional competitiveness with a mathematical adjustment model. The conceptual framework establishes the hypothetical relationship between inputs and outcomes. The mathematical model provides structure to those relationships, and it suggests the specification for econometric models to test the hypothesized relationship. The findings from the estimations may be used to determine the weights of variables in metropolitan economic competitiveness indices and the role of industrial structure and legacy on economic competitiveness.

### *Regional Competitiveness Pyramid Framework*

This study adopts a conceptual framework similar to the pyramids used by Gardiner (2003) and the National Competitiveness Council (2007). The pyramid framework is shown in Figure 3.1. The key feature of the regional competitiveness pyramid is that policy inputs to the competitiveness process are filtered through the local environment for development. Economic development strategies interact with the region's economic structure. The quality of these interactions determines the outcomes of the competitiveness process.

The base of the pyramid contains the principal inputs to economic competitiveness in the New Economy as identified in previous benchmarking studies: innovation inputs, knowledge workers, labor employability, and entrepreneurial environment. These competitive inputs may be influenced by economic development policies. The middle layer describes the environment for development in terms of the

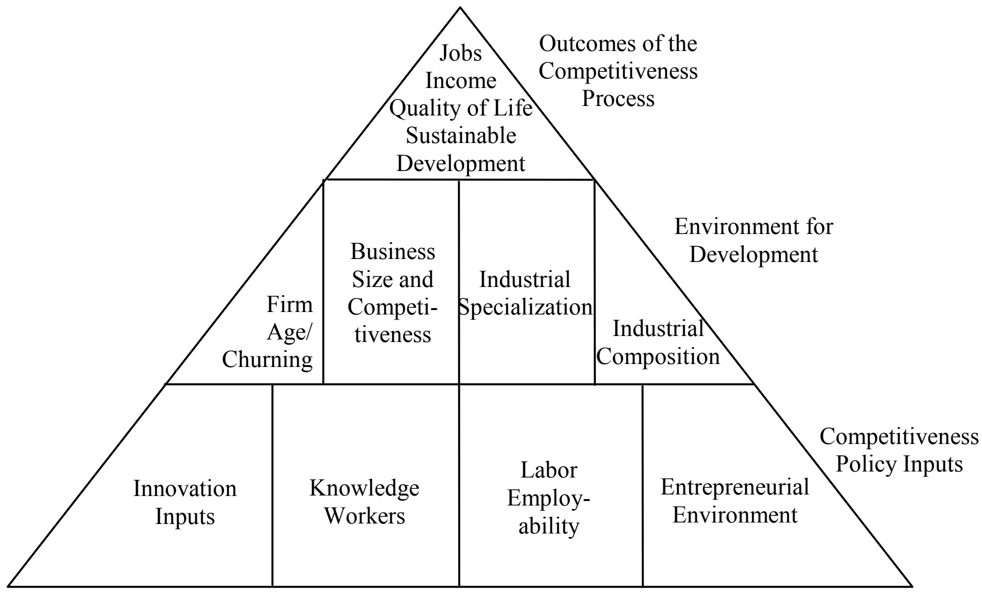


Figure 3.1. Regional competitiveness pyramid.

region's industrial structure and legacy consisting of establishment age/churning, business size/competitiveness, industrial composition, and industrial specialization. The competitiveness inputs are filtered through the environment for development to achieve regional competitiveness outcomes. Outcomes of the competitiveness process include income, jobs, quality of life, and sustainable development. Each box in Figure 3.1 represents an element of regional competitiveness identified in earlier research on the determinants of regional growth. These elements and the variables selected to represent them are provided in Table 3.1.

A region's social, cultural, and institutional environment is important to regional competitiveness (Bristow, 2005; Brooks, 2003). However, the data describing regional

Table 3.1. Competitiveness Variables, and Citations of Past Use.

| Element | Variable | Citations of Past Use |
|---|---|---|
| Outcomes | Growth rate of population | Carlino and Mills (1987); Caurrthers and Mulligan (2008); Glaeser (1995) |
| | Growth rate of employment | Carlino and Mills (1987); Caurrthers and Mulligan (2008); Corporation for Enterprise Development (2007) |
| | Growth rate of per capita income | Caurrthers and Mulligan (2008); Glaeser (1995); Huggins (2004) |
| Measures of the Competitiveness Policy Inputs: | | |
| Innovation inputs | Graduate students in science and engineering per 10,000 residents | CFED (2007); Tuerck et al. (2007b, 2008) |
| | Science and engineering PhD's per 10,000 residents | Atkinson and Gottlieb (2001); CFED (2007) |
| | Academic R&D spending per capita | Atkinson and Gottlieb (2001); CFED (2007); Tuerck et al. (2007b, 2008) |
| | College and graduate school enrollment per 10,000 population | Austrian et al. (2007); Tuerck et al. (2007b, 2008) |
| | Percent of population ages 25+ with an advanced degree | Eberts et al. (2006) |
| | Percent of employment in computer, science, and engineering occupations | Atkinson and Correa (2007); Gardiner (2003); Indiana (2007) |
| | Patents per 10,000 workers | Atkinson and Gottlieb (2001); Eberts et al. (2006); CFED (2007) |
| | Venture capital investment per capita, 2000-2006 | Atkinson and Correa (2007); Austrian et al. (2007); CFED (2007); Tuerck et al. (2007) |
| Knowledge workers | Percent of employment in computer, science, and engineering occupations | Atkinson and Correa (2007); Gardiner (2003); Indiana (2007) |
| | Percent of employment in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations | Huggins (2004); Indiana (2007) |
| | Percent of employment in professional, scientific, and technical services industries | Atkinson and Correa (2007); Atkinson and Gottlieb (2001); Barkley et al. (2006a) |
| | Percent of employment in manufacturing sectors | Carruthers and Mulligan (2008), Eberts et al. (2006), Glaeser et al. (1995) |
| | Percent of population ages 25+ with a bachelor's degree | Eberts et al. (2006); Indiana (2007) |
| | Percent of population ages 25+ with less than high a school diploma | Eberts et al. (2006); Tuerck et al. (2007b, 2008) |

Continued.

Table 3.1. Competitiveness Variables, and Citations of Past Use, Continued.

| Measures of the Competitiveness Policy Inputs: | | |
|---|---|---|
| Element | Variable | Citations of Past Use |
| Labor employability | Percent of population ages 25+ with less than high a school diploma | Eberts et al. (2006); Tuerck et al. (2007b, 2008) |
| | Percent of population of working age (25-64) | Eberts et al. (2006); Huovari et al. (2001)[a] |
| | Labor force participation rate | Tuerck et al. (2007b, 2008) |
| | Employment rate (employed/labor force) | Eberts et al. (2006); Huggins (2004); Tuerck et al. (2007b, 2008)[b] |
| | Percent of population who speak English well | Eberts et al. (2006); Tuerck et al. (2007b, 2008)[c] |
| | Out-of-poverty rate | Austrian et al. (2007); Eberts et al. (2006)[b] |
| Entrepreneurial environment | Number of proprietors per capita | Austrian et al. (2007) |
| | Proprietors' income as a share of total earnings | Donegan et al. (2008); Mack et al. (2007) |
| | Percent of population that is a racial minority | Carlino and Mills (1987); Eberts et al. (2006); Glaeser (1995) |
| Measures of the Environment for Development: | | |
| Establishment age and churning | Percent of establishments fewer than 5 years old | Steinle (1992)[d]; Markusen (1985)* |
| | Business churning ([births + deaths]/initial establishments) | Austrian et al. (2007); Eberts et al. (2006) |
| Business size and competitiveness | Establishments per employee | Glaeser et al. (1992); Huggins (2004) |
| | Percent of establishments with fewer than 20 employees | Austrian et al. (2007); Eberts et al. (2006) |
| Industrial specialization | Employment specialization index | Barkley et al. (2006a); Glaeser et al. (1992) Nissan and Carter (2006) |
| Industrial composition | Relative wage of occupations in traded industries | Harvard Business School (2007); Donegan et al. (2008)*; Porter (2002)* |

*Asterisked citations are neither benchmarking studies nor competitiveness models, but the authors note the importance of the variable.

[a]The cited authors use the population ages 16-64 as a measure of persons who could participate in the labor force. However, the new economy jobs that are determined to be important in this and other studies are held predominantly by persons who have obtained a college degree, which makes the 25-64-year-old age group a more appropriate measure.

[b]The cite authors measure the unemployment and poverty rates. The opposites of those rates are used here to facilitate intuitive interpretation of factors.

[c]Cited authors measure the percent of residents who are foreign born. The English proficiency measure captures effects of foreign born persons and ethnic minorities who may speak a foreign language for multiple generations (e.g., Hispanics, the presence of whom Eberts [2006] also measures).

[d]Steinle measures establishment age, but establishment data were available only by age group from the Census Bureau (2008).

institutions and cultures are scarce; thus, this study focuses on the industrial structure and diversity aspects of the environment for development.

There is no reason to expect that all competitiveness inputs affect economic outcomes with the same magnitude (Atkinson and Gottlieb, 2001; Atkinson and Correa, 2007; Eberts et al., 2006). Furthermore, inputs are unlikely to have the same effect on all measures of outcomes (e.g., jobs vs. incomes). For example, labor force education and skills may affect changes in employment and income more than changes in population, and entrepreneurial activity may stimulate growth in employment more than growth in income. A principal goal of the proposed econometric analysis is to test for the potential differential effects of policy variables on regional outcome growth rates.

*Econometric Models*

Following the Kitson et al. (2004, p. 997) definition of competitive regions as "places where both companies and people want to locate and invest in," both the Glaeser et al. (1995) and the Carruthers-Mulligan (2008) models are used to estimate the determinants of regional competitiveness outcomes (change in population, employment, and per capita income from 2000 to 2006). The Glaeser et al. and Carruthers-Mulligan model specifications provide different perspectives on regional adjustment, and the models are used to determine the sensitivity of estimates to the model specification. Glaeser et al. (1995) treat the equations for changes in population, employment, and income as separate equations. Carruthers and Mulligan (2008) treat the equations as a simultaneous system.

The rate of change in per capita income captures the productivity component of regional competitiveness in both of the models. The rates of population and employment change measure the attractiveness of the region to people and companies, respectively.[42] The Glaeser et al. (1995) and Carruthers-Mulligan (2008) models estimate the change in economic outcomes based on adjustments to lagged values of the outcomes and a set of initial conditions.[43]

This research differs from that of Glaeser et al. (1995) and Carruthers and Mulligan (2008) in that the dependent variables are lagged to 2000 on the right-hand-side of the equation while initial conditions are lagged to 1990. This approach is used to reduce bias resulting from potential endogeneity. Additional regressions are estimated for the cases where the lag periods for the dependent variables and the initial conditions are equal, and similar results are obtained.

This study focuses on short-run changes in regional competitiveness that result from changes in the selected policy inputs. Neither the Glaeser et al. model nor the Carruthers and Mulligan model includes all of the policy inputs that may influence economic competitiveness (e.g., miles of interstate highway and availability of air transportation). However, the equations focus on period-to-period innovations to each region's labor, capital, technology, and environment for development. Static factors are cancelled out in the differencing process, thus decreasing the potential for omitted variable bias.

Two cases of the Glaeser et al. and Carruthers-Mulligan specifications are estimated. Case one includes the base year outcome variables and the initial conditions.

The estimation results from case one indicate whether variables make the same contribution to each outcome (growth in population, employment, and per capita income) and thus whether variables should have the same weight in an index or benchmarking study regardless of the competitiveness outcome measured. Case two adds interaction terms between the policy and industrial structure/legacy variables to the case one estimations. The case two estimation results indicate whether regions with different industrial structures and histories respond differently to economic policies and thus whether variables in a competitiveness index should be weighted differently for different sizes or types of cities.

Glaeser et al. Model. Glaeser et al.'s (1995) equations for the adjustments in regional population and wages (Equations 3.10 and 3.11) are modified to reflect the parameters of this study, and an equation for employment change is added.[44] For each MSA, the logged ratios of population ($P$), employment (E), and per capita income ($y$) at time $t$ and $t$-$i$ are

$$\ln\left(\frac{P_t}{P_{t-i}}\right) = \alpha_{0P} + \alpha_{1P} \ln P_{t-i} + \alpha_{2P} y_{t-i} + X_{t-i}^{'} \beta_P + \varepsilon_{P,t}\,, \tag{3.28}$$

$$\ln\left(\frac{E_t}{E_{t-i}}\right) = \alpha_{0E} + \alpha_{1E} \ln P_{t-i} + \alpha_{2E} y_{t-i} + X_{t-i}^{'} \beta_E + \varepsilon_{E,t}\,, \tag{3.29}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \alpha_{0y} + \alpha_{1y} \ln P_{t-i} + \alpha_{2y} y_{t-i} + X_{t-i}^{'} \beta_y + \varepsilon_{y,t}\,, \tag{3.30}$$

where $i$ is the lag period. The $X$ term is a vector of policy and structure/legacy variables expected to affect productivity and to influence local quality of life.[45] The lagged dependent variables are included explicitly in the equations to test the regional convergence hypothesis. Population is logged where is appears on the right-hand side of the equations, but per capita income is not logged in the Glaeser et al. specification.

Equations 3.28, 3.29, and 3.30 can also be expressed as

$$\ln\left(\frac{P_t}{P_{t-i}}\right) = \alpha_{0P} + \alpha_{1P}\ln P_{t-i} + \alpha_{2P}y_{t-i} + \sum_{j=1}^{n}(\beta_{jP}x_{j,t-i}) + \varepsilon_{P,t}\,, \tag{3.31}$$

$$\ln\left(\frac{E_t}{E_{t-i}}\right) = \alpha_{0E} + \alpha_{1E}\ln P_{t-i} + \alpha_{2E}y_{t-i} + \sum_{j=1}^{n}(\beta_{jE}x_{j,t-i}) + \varepsilon_{E,t}\,, \tag{3.32}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \alpha_{0y} + \alpha_{1y}\ln P_{t-i} + \alpha_{2y}y_{t-i} + \sum_{j=1}^{n}(\beta_{jy}x_{j,t-i}) + \varepsilon_{y,t}\,, \tag{3.33}$$

where the *j* subscripts represent variables or factors. The *x* terms are the components of the *X* vector, and they may be statistically correlated variable groupings that characterize the policy and industrial legacy elements of the competitiveness pyramid.[46]

The Glaeser et al. specification is estimated in two cases. Case one is the base model that estimates each variable's influence on each of the three outcome measures. Case two tests whether policy inputs are affected by a region's economic structure and legacy. The Glaeser et al. specification for case one includes only the lagged dependent variables, the policy inputs, and variables selected to represent the industrial structure and legacy of each MSA:

$$\ln\left(\frac{P_t}{P_{t-i}}\right) = \begin{aligned}&\alpha_{0P} + \alpha_{1P}\ln P_{t-i} + \alpha_{2P}y_{t-i} + \beta_{1P}INNOV_{t-i} + \beta_{2P}KNOW_{t-i}\\ &+ \beta_{3P}LABOR_{t-i} + \beta_{4P}ENT_{t-i} + \beta_{5P}AGE_{t-i} + \beta_{6P}SIZE_{t-i}\\ &+ \beta_{7P}SPEC_{t-i} + \beta_{8P}COMP_{t-i} + \varepsilon_{P,t}\end{aligned}\,, \tag{4.34}$$

$$\ln\left(\frac{E_t}{E_{t-i}}\right) = \begin{array}{l} \alpha_{0E} + \alpha_{1E}\ln P_{t-i} + \alpha_{2E}y_{t-i} + \beta_{1E}INNOV_{t-i} + \beta_{2E}KNOW_{t-i} \\ + \beta_{3E}LABOR_{t-i} + \beta_{4E}ENT_{t-i} + \beta_{5E}AGE_{t-i} + \beta_{6E}SIZE_{t-i} \\ + \beta_{7E}SPEC_{t-i} + \beta_{8E}COMP_{t-i} + \varepsilon_{E,t} \end{array}, \tag{4.35}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \begin{array}{l} \alpha_{0y} + \alpha_{1y}\ln P_{t-i} + \alpha_{2y}y_{t-i} + \beta_{1y}INNOV_{t-i} + \beta_{2y}KNOW_{t-i} \\ + \beta_{3y}LABOR_{t-i} + \beta_{4y}ENT_{t-i} + \beta_{5y}AGE_{t-i} + \beta_{6y}SIZE_{t-i} \\ + \beta_{7y}SPEC_{t-i} + \beta_{8y}COMP_{t-i} + \varepsilon_{y,t} \end{array}, \tag{4.36}$$

where:

$P_t$ = population at time *t*
$P_{t-i}$ = population at time *t-i*
$E_t$ = employment at time *t*
$E_{t-i}$ = employment at time *t-i*
$y_t$ = per capita income at time *t*
$y_{t-i}$ = per capita income at time *t-i*
$INNOV_{t-i}$ = innovation inputs at time *t-i*
$KNOW_{t-i}$ = availability of knowledge workers at time *t-i*
$LABOR_{t-i}$ = labor force availability and quality at time *t-i*
$ENT_{t-i}$ = entrepreneurial activity at time *t-i*
$AGE_{t-i}$ = establishment age and churning at time *t-i*
$SIZE_{t-i}$ = business size and competitiveness at time *t-i*
$SPEC_{t-i}$ = industrial specialization at time *t-i*
$COMP_{t-i}$ = industrial composition at time *t-i.*

Most benchmarking studies rely on an input-output approach to measure regional competitiveness. This approach considers only the policy inputs and the outcomes of the competitive process on the regional competitiveness pyramid. One of the objectives of this study is to evaluate the role of the environment for development (i.e., industrial structure and legacy) in determining the competitiveness of Southern MSAs. Case two includes interaction terms between the policy inputs and the industrial structure/legacy elements. Thus, the empirical model for each MSA extends to

$$\ln\left(\frac{P_t}{P_{t-i}}\right) = \begin{array}{l} \alpha_{0P} + \alpha_{1P}\ln P_{t-i} + \alpha_{2P}y_{t-i} + \beta_{1P}INNOV_{t-i} + \beta_{2P}KNOW_{t-i} \\ + \beta_{3P}LABOR_{t-i} + \beta_{4P}ENT_{t-i} + \beta_{5P}AGE_{t-i} + \beta_{6P}SIZE_{t-i} \\ + \beta_{7P}SPEC_{t-i} + \beta_{8P}COMP_{t-i} + \beta_{9P}INTX_{t-i} + \varepsilon_{P.t} \end{array}, \tag{4.37}$$

$$\ln\left(\frac{E_t}{E_{t-i}}\right) = \begin{array}{l}\alpha_{0E} + \alpha_{1E}\ln P_{t-i} + \alpha_{2E}y_{t-i} + \beta_{1E}INNOV_{t-i} + \beta_{2E}KNOW_{t-i} \\ + \beta_{3E}LABOR_{t-i} + \beta_{4E}ENT_{t-i} + \beta_{5E}AGE_{t-i} + \beta_{6E}SIZE_{t-i} \\ + \beta_{7E}SPEC_{t-i} + \beta_{8E}COMP_{t-i} + \beta_{9E}INTX_{t-i} + \varepsilon_{E,t}\end{array} \quad , \tag{4.38}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \begin{array}{l}\alpha_{0y} + \alpha_{1y}\ln P_{t-i} + \alpha_{2y}y_{t-i} + \beta_{1y}INNOV_{t-i} + \beta_{2y}KNOW_{t-i} \\ + \beta_{3y}LABOR_{t-i} + \beta_{4y}ENT_{t-i} + \beta_{5y}AGE_{t-i} + \beta_{6y}SIZE_{t-i} \\ + \beta_{7y}SPEC_{t-i} + \beta_{8y}COMP_{t-i} + \beta_{9y}INTX_{t-i} + \varepsilon_{y,t}\end{array} \quad , \tag{4.39}$$

where $INTX_{t-1}$ is a single interaction between policy and legacy variables. Interactions for each of the 28 possible combinations of policy and legacy/structure variables are added one at a time to estimations in order to maintain the degrees of freedom needed to calculate standard errors and make valid statistical inferences. A significant coefficient on an interaction term indicates that the association of one explanatory variable on the competitiveness outcome depends on the value of the other explanatory variable (Wooldridge, 2003).

Carruthers and Mulligan Model. Carruthers and Mulligan (2008) offer a second specification of the empirical model. Like Glaeser et al. (1995), Carruthers and Mulligan model the natural logs of the rates of change in population density, employment density, and per capita income. The Carruthers-Mulligan specification differs from that of Glaeser et al. in two ways. First, the Carruthers-Mulligan specification is a simultaneous system of equations in which each outcome influences the other two outcomes. Second, the Carruthers-Mulligan includes the logs rather than levels of per capita income and the logs of population and employment per square mile rather than the logs of population and employment. These differences test the sensitivity of the results to the model specification.

The Carruthers-Mulligan model notation presented in Equations 3.21 though 3.23 is adjusted to reflect the notation used in the Glaeser et al. specification. The natural log of each dependent variable's rate of change is a function of its lagged natural log, the current logs of the other two endogenously determined variables, and a vector of initial regional conditions ($x_{i,t-i}$) such as industrial composition and human capital:

$$\ln\left(\frac{p_t}{p_{t-i}}\right) = \alpha_{0p} + \alpha_{1p} \ln p_{t-i} + \alpha_{2p} \ln e_t + \alpha_{3p} \ln y_t + \beta X_{t-i} + \varepsilon_{p,t}, \tag{3.40}$$

$$\ln\left(\frac{e_t}{e_{t-i}}\right) = \alpha_{0e} + \alpha_{1e} \ln p_t + \alpha_{2e} \ln e_{t-1} + \alpha_{3e} \ln y_t + \beta X_{t-i} + \varepsilon_{e,t}, \tag{3.41}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \alpha_{0y} + \alpha_{1y} \ln p_t + \alpha_{2y} \ln e_t + \alpha_{3y} \ln y_{t-i} + \beta X_{t-i} + \varepsilon_{y,t}. \tag{3.42}$$

The lower case *p* and *e* represent population per square mile and employment per square mile, respectively, and all other variables are defined as in the Glaeser et al. specification.

Equations 3.40, 3.41, and 3.42 can also be expressed:

$$\ln\left(\frac{p_t}{p_{t-i}}\right) = \alpha_{0p} + \alpha_{1p} \ln p_{t-i} + \alpha_{2p} \ln e_t + \alpha_{3p} \ln y_t + \sum_{j=1}^{n} (\beta_{jp} x_{j,t-i}) + \varepsilon_{p,t}, \tag{3.43}$$

$$\ln\left(\frac{e_t}{e_{t-i}}\right) = \alpha_{0e} + \alpha_{1e} \ln p_t + \alpha_{2e} \ln e_{t-1} + \alpha_{3e} \ln y_t + \sum_{j=1}^{n} (\beta_{je} x_{j,t-i}) + \varepsilon_{e,t}, \tag{3.44}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \alpha_{0y} + \alpha_{1y} \ln p_t + \alpha_{2y} \ln e_t + \alpha_{3y} \ln y_{t-i} + \sum_{j=1}^{n} (\beta_{jy} x_{j,t-i}) + \varepsilon_{y,t}. \tag{3.45}$$

Two cases of the Carruthers-Mulligan model specification are estimated. Case one estimates the effects of the policy and industrial structure/legacy variables on the three competitiveness outcomes (change in population, employment, and per capita income). Case two estimates the interactions of economic policies and various industrial structures and legacies to determine if cities with different histories respond differently to economic stimuli. Case one of the Carruthers-Mulligan specification includes only the lagged and simultaneous outcomes, the policy inputs, and the industrial structure/legacy measures:

$$\ln\left(\frac{p_t}{p_{t-i}}\right) = \begin{aligned}&\alpha_{0p} + \alpha_{1p}\ln p_{t-i} + \alpha_{2p}\ln e_t + \alpha_{3p}\ln y_t + \beta_{1p}INNOV_{t-i} \\ &+ \beta_{2p}KNOW_{t-i} + \beta_{3p}LABOR_{t-i} + \beta_{4p}ENT_{t-i} + \beta_{5p}AGE_{t-i} \\ &+ \beta_{6p}SIZE_{t-i} + \beta_{7p}SPEC_{t-i} + \beta_{8p}COMP_{t-i} + \varepsilon_{p,t}\end{aligned} \quad , \tag{3.46}$$

$$\ln\left(\frac{e_t}{e_{t-i}}\right) = \begin{aligned}&\alpha_{0e} + \alpha_{1e}\ln p_t + \alpha_{2e}\ln e_{t-i} + \alpha_{3e}\ln y_t + \beta_{1e}INNOV_{t-i} \\ &+ \beta_{2e}KNOW_{t-i} + \beta_{3e}LABOR_{t-i} + \beta_{4e}ENT_{t-i} + \beta_{5e}AGE_{t-i} \\ &+ \beta_{6e}SIZE_{t-i} + \beta_{7e}SPEC_{t-i} + \beta_{8e}COMP_{t-i} + \varepsilon_{e,t}\end{aligned} \quad , \tag{3.47}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \begin{aligned}&\alpha_{0y} + \alpha_{1y}\ln p_t + \alpha_{2y}\ln e_t + \alpha_{3y}\ln y_{t-i} + \beta_{1y}INNOV_{t-i} \\ &+ \beta_{2y}KNOW_{t-i} + \beta_{3y}LABOR_{t-i} + \beta_{4y}ENT_{t-i} + \beta_{5y}AGE_{t-i} \\ &+ \beta_{6y}SIZE_{t-i} + \beta_{7y}SPEC_{t-i} + \beta_{8y}COMP_{t-i} + \varepsilon_{y,t}\end{aligned} \quad , \tag{3.48}$$

where, as in the Glaeser et al. specification:

$p_t$ = population density at time *t*
$p_{t-i}$ = population density at time *t-i*
$e_t$ = employment density at time *t*
$e_{t-i}$ = employment density at time *t-i*
$y_t$ = per capita income at time *t*
$y_{t-i}$ = per capita income at time *t-i*
$INNOV_{t-i}$ = innovation inputs at time *t-i*
$KNOW_{t-i}$ = availability of knowledge workers at time *t-i*
$LABOR_{t-i}$ = labor force availability and quality at time *t-i*
$ENT_{t-i}$ = entrepreneurial activity at time *t-i*
$AGE_{t-i}$ = establishment age and churning at time *t-i*
$SIZE_{t-i}$ = business size and competitiveness at time *t-i*
$SPEC_{t-i}$ = industrial specialization at time *t-i*
$COMP_{t-i}$ = industrial composition at time *t-i.*

Case two of the Carruthers-Mulligan specification is estimated to determine whether economic policies have different effects in MSAs with different industrial structures and legacies. Case two includes the lagged and simultaneous outcome measures, the competitiveness inputs, the industrial structure/legacy variables, and the interactions between the inputs and legacy measures:

$$\ln\left(\frac{p_t}{p_{t-i}}\right) = \begin{aligned} &\alpha_{0p} + \alpha_{1p}\ln p_{t-i} + \alpha_{2p}\ln e_t + \alpha_{3p}\ln y_t + \beta_{1p}INNOV_{t-i} \\ &+ \beta_{2p}KNOW_{t-i} + \beta_{3p}LABOR_{t-i} + \beta_{4p}ENT_{t-i} + \beta_{5p}AGE_{t-i} \\ &+ \beta_{6p}SIZE_{t-i} + \beta_{7p}SPEC_{t-i} + \beta_{8p}COMP_{t-i} + \beta_{9p}INTX_{t-i} + \varepsilon_{p,t}, \end{aligned} \tag{3.49}$$

$$\ln\left(\frac{e_t}{e_{t-i}}\right) = \begin{aligned} &\alpha_{0e} + \alpha_{1e}\ln p_t + \alpha_{2e}\ln e_{t-i} + \alpha_{3e}\ln y_t + \beta_{1e}INNOV_{t-i} \\ &+ \beta_{2e}KNOW_{t-i} + \beta_{3e}LABOR_{t-i} + \beta_{4e}ENT_{t-i} + \beta_{5e}AGE_{t-i} \\ &+ \beta_{6e}SIZE_{t-i} + \beta_{7e}SPEC_{t-i} + \beta_{8e}COMP_{t-i} + \beta_{9e}INTX_{t-i} + \varepsilon_{e,t} \end{aligned} \tag{3.50}$$

and

$$\ln\left(\frac{y_t}{y_{t-i}}\right) = \begin{aligned} &\alpha_{0y} + \alpha_{1y}\ln p_t + \alpha_{2y}\ln e_t + \alpha_{3y}\ln y_{t-i} + \beta_{1y}INNOV_{t-i} \\ &+ \beta_{2y}KNOW_{t-i} + \beta_{3y}LABOR_{t-i} + \beta_{4y}ENT_{t-i} + \beta_{5y}AGE_{t-i} \\ &+ \beta_{6y}SIZE_{t-i} + \beta_{7y}SPEC_{t-i} + \beta_{8y}COMP_{t-i} + \beta_{9y}INTX_{t-i} + \varepsilon_{y,t} \end{aligned} \tag{3.51}$$

where $INTX_{t-1}$ is a single interaction between policy and legacy variables. Interactions for each of the 28 possible combinations of policy and legacy/structure variables are added one at a time to the Carruthers-Mulligan estimations, as in the Glaeser et al. specification.

## Data Collection

*Study area*

Data is collected and analyzed for 151 MSAs in the Southern US Census Region.[47] The states that make up the South are Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia (Census Bureau, 2007b). The

Washington, DC MSA is excluded from this study because, as the nation's capitol, Washington is dominated by government activity. Washington's economy is fundamentally different from those of other Southern cities.

Fisher (2005) and Atkinson and Gottlieb (2001) find that the appropriate level of study is the metropolitan area. Metropolitan areas are more cohesive economic units than states. Metropolitan areas share common labor markets and other resources (Haughton and Murg, 2002). Economic conditions can vary dramatically within a state (Fisher, 2005), and the variation of economic factors may be greater within a state than between states (Atkinson, 1990).

Each MSA is made up of one or more counties that comprise and surround an urban core. The US Bureau of the Census (Census Bureau) periodically updates the MSAs' boundaries to reflect commuting and population patterns. This study uses the Census Bureau's 2003 MSA definitions that also are used in the 2006 American Community Survey (Census Bureau, 2007c). The MSA boundaries are different for the 2000 and 1990 Censuses (Census Bureau, 2002c, 2001a). Furthermore, some 2006 MSAs were not considered MSAs in 2000 or 1990 or were combined with another metropolitan area or areas in those years.[48] The 2000 and 1990 MSA data are adjusted using county-level data to conform to the MSA definitions in effect in 2003 and 2006. A list of the MSAs included in the study and their component counties in 2006, 2000, and 1990 is provided in Appendix C.

*Variable Selection and Measures*

Many of the determinants of economic growth are difficult to measure (e.g., social capital) or are fairly constant over time (e.g., the distance to other MSAs and the proximity of ports and airports). In this study, variables believed to be responsive to policy changes and inputs in the short-run are used to benchmark rates of change in population, employment, and per capita income in the MSAs of US South. Data are collected for each of the Southern MSAs for 1990, 2000, and 2006. In some cases, data is not available for a particular year so data from the nearest year is used in its place. For example, the number of PhD students in science and engineering fields is not available for 1990, so the 1994 (earliest available) data is used instead. The data sources and the years for which data are collected for each variable are identified in Table 3.2 and described below. The variable descriptions are grouped according to the sections of the regional competitiveness pyramid. Descriptive statistics for the variables are provided in Table 3.3.

Table 3.2. Competitiveness Variables, Years, and Data Sources.

| Element | Variable | Year | Data Source |
|---|---|---|---|
| Outcomes | Growth rate of population (and lagged population) | 2006 | US Census Bureau, 2007a, 2006 American Community Survey, Table B01003 |
| | | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P1 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P001 |
| | Growth rate of employment (and lagged employment) | 2006 | US Census Bureau, 2008a, County Business Patterns |
| | | 2000 | US Census Bureau, 2008a, County Business Patterns |
| | | 1990 | US Census Bureau, 2008a, County Business Patterns |
| | Growth rate of per capita income (and lagged per capita income) | 2006 | US Census Bureau, 2007a, 2006 American Community Survey, Table B19301 |
| | | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P82 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P114A |
| Measures of the Competitiveness Policy Inputs: | | | |
| Innovation inputs | College and graduate school enrollment per 10,000 population | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P36 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P054 |
| | Percent of population ages 25+ with an advanced degree | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P37 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P054 |
| | Graduate students in science and engineering per 10,000 residents | 2000 | National Science Foundation, 2002b |
| | | 1994 | National Science Foundation, 1996 |
| | Science and engineering PhD's per 10,000 residents | 2000 | National Science Foundation, 2001 |
| | | 1994 | National Science Foundation, 1995 |
| | Academic R&D spending per capita | 2000 | National Science Foundation, 2002a |
| | | 1990 | National Science Foundation, 1999 |
| | Percent of employment in computer, science, and engineering occupations | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P50 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P078 |
| | Patents per 10,000 workers | 2000 | Harvard Business School, 2008 |
| | | 1990 | Harvard Business School, 2008 |
| | Venture capital investment per capita, 2000-2006 | 2000 | PricewaterhouseCoopers, 2008 |
| | | 1990 | PricewaterhouseCoopers, 2008 |

Continued.

Table 3.2. Competitiveness Variables, Years, and Data Sources, Continued.

| Measures of the Competitiveness Policy Inputs, Continued: | | | |
|---|---|---|---|
| Element | Variable | Year | Data Source |
| Knowledge workers | Percent of employment in computer, science, and engineering occupations | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P50 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P078 |
| | Percent of employment in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P50 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P078 |
| | Percent of employment in professional, scientific, and technical services industries | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P49 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P077 |
| | Percent of employment in manufacturing sectors | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P49 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P077 |
| | Percent of population ages 25+ with a bachelor's degree | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P37 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P054 |
| | Percent of population ages 25+ with less than high a school diploma | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P37 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P054 |
| Labor employability | Percent of population ages 25+ with less than high a school diploma | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P37 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P054 |
| | Percent of population of working age (25-64) | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P8 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P013 |
| | Labor force participation rate | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P43 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P070 |
| | Employment rate (employed/labor force) | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P43 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P070 |
| | Percent of population who speak English well | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P19 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P028 |
| | Out-of-poverty rate | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P87 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P117 |
| Entrepreneurial environment | Number of proprietors per capita | 2000 | US BEA, 2008, Local Area Personal Income, Table CA030 |
| | | 1990 | US BEA, 2008, Local Area Personal Income, Table CA030 |
| | Proprietors' income as a share of total earnings | 2000 | US BEA, 2008, Local Area Personal Income, Table CA05 |
| | | 1990 | US BEA, 2008, Local Area Personal Income, Table CA05 |
| | Percent of population that is a racial minority | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P6 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P008 |

Continued.

Table 3.2. Competitiveness Variables, Years, and Data Sources, Continued.

| Measures of the Environment for Development: | | | |
|---|---|---|---|
| Element | Variable | Year | Data Source |
| Establishment age and churning | Percent of establishments fewer than 5 years old | 2000 | US Census Bureau, 2008b, Special Tabulation |
| | | 1990 | US Census Bureau, 2008b, Special Tabulation |
| | Business churning ([births + deaths]/initial establishments) | 2000 | US Census Bureau, 2001b, 2000-2001 Statistics of US Businesses |
| | | 1998 | US Census Bureau, 1999, 1998-1999 Statistics of US Businesses |
| Business size and competitiveness | Establishments per employee | 2000 | US Census Bureau, 2008a, County Business Patterns |
| | | 1990 | US Census Bureau, 2008a, County Business Patterns |
| | Percent of establishmets with fewer than 20 employees | 2000 | US Census Bureau, 2008a, County Business Patterns |
| | | 1990 | US Census Bureau, 2008a, County Business Patterns |
| Industrial specialization | Employment specialization index | 2000 | US Census Bureau, 2002b, 2000 Decennial Census, Table P49 |
| | | 1990 | US Census Bureau, 1993, 1990 Decennial Census, Table P077 |
| Industrial composition | Relative wage of occupations in traded industries | 2000 | Harvard Business School, 2008 |
| | | 1990 | Harvard Business School, 2008 |

Table 3.3. Descriptive Statistics.

| Variable | Mean | Med. | Min. | Max. | S.D. |
|---|---|---|---|---|---|
| Growth rate of population, 2000-2006 | 0.0732 | 0.0667 | -0.2846 | 0.5033 | 0.0803 |
| Growth rate of employment, 2000-2006 | 0.0909 | 0.0764 | -0.2277 | 0.7120 | 0.1020 |
| Growth rate of per capita income, 2000-2006 | 0.1543 | 0.1537 | -0.0185 | 0.3453 | 0.0536 |
| Population, 2006 | 557,768.33 | 240,450.50 | 71,667 | 5,982,787 | 954,544.68 |
| Employment, 2006 | 261,731.99 | 116,224.00 | 26,745 | 2,977,990 | 465,670.42 |
| Per capita income, 2006 | 22,076.24 | 21,496.50 | 11,919 | 34,650 | 3,580.58 |
| Population, 2000 | 507,829.85 | 227,569.00 | 49,832 | 5,161,544 | 845,857.62 |
| Employment, 2000 | 233,344.03 | 101,289.00 | 18,815 | 2,550,873 | 400,279.30 |
| Per capita income, 2000 | 18,892.78 | 18,403.73 | 9,899 | 31,195 | 2,921.95 |
| Population, 1990 | 425,571.78 | 192,018.50 | 28,701 | 4,056,100 | 670,269.79 |
| Employment, 1990 | 196,796.60 | 81,021.50 | 10,542 | 2,055,606 | 328,981.62 |
| Per capita income, 1990 | 12,321.36 | 12,044.43 | 6,630.00 | 21,386.00 | 2,008.43 |
| Graduate students in science and engineering per 10,000 residents | 19.06 | 4.76 | 0.00 | 322.39 | 44.99 |
| Science and engineering PhD's per 10,000 residents | 1.15 | 0.00 | 0.00 | 28.74 | 3.61 |
| Academic R&D spending per capita | 73.93 | 0.0000 | 0.0000 | 1,806.65 | 224.83 |
| College and graduate school enrollment per 10,000 residents | 719.69 | 630.51 | 288.89 | 2,707.92 | 392.86 |
| Percent of population ages 25+ with an advanced degree | 6.03% | 5.52% | 2.62% | 16.19% | 2.32% |
| Percent of employment in computer, science, and engineering occupations | 4.64% | 4.55% | 2.77% | 7.79% | 0.87% |
| Patents per 10,000 workers | 2.87 | 2.26 | 0.26 | 11.75 | 2.21 |
| Venture capital investment per capita, 2000-2006 | 79.68 | 0.0000 | 0.0000 | 1,875.82 | 236.31 |
| Percent of employment in management, business/ operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations | 37.93% | 37.88% | 27.05% | 49.55% | 4.24% |
| Percent of employment in professional, scientific, and technical services industries | 4.06% | 4.03% | 2.39% | 5.90% | 0.68% |
| Percent of population ages 25+ with a bachelor's degree | 11.22% | 10.67% | 5.99% | 20.72% | 3.04% |
| Percent of population ages 25+ with less than high a school diploma | 28.76% | 27.96% | 16.23% | 53.39% | 6.31% |
| Percent of population of working age (25-64) | 50.12% | 50.16% | 41.15% | 55.49% | 2.67% |
| Labor force participation rate | 48.80% | 49.17% | 36.36% | 61.46% | 4.23% |
| Employment rate (employed/labor force) | 93.72% | 93.84% | 85.69% | 96.77% | 1.77% |
| Percent of population who speak English well | 98.47% | 99.40% | 77.56% | 99.82% | 3.30% |
| Out-of-poverty rate | 83.95% | 84.76% | 58.12% | 92.45% | 5.50% |
| Number of proprietors per capita | 0.0729 | 0.0694 | 0.0223 | 0.1767 | 0.0213 |
| Proprietors' income as a share of total earnings | 0.0867 | 0.0842 | 0.0303 | 0.2308 | 0.0291 |
| Percent of population that is a racial minority | 20.44% | 20.66% | 1.60% | 45.72% | 11.00% |
| Establishments per employee | 0.0712 | 0.0693 | 0.0470 | 0.1052 | 0.0125 |
| Percent of establishments with fewer than 20 employees | 87.03% | 86.92% | 82.84% | 91.79% | 1.60% |
| Percent of employment fewer than 5 years old | 44.18% | 43.56% | 33.82% | 60.79% | 4.68% |
| Business churning ([births + deaths]/initial establishments) | 0.2226 | 0.2200 | 0.1550 | 0.3265 | 0.0278 |
| Relative wage of occupations in traded industries | 0.7387 | 0.7257 | 0.3808 | 1.2957 | 0.1402 |
| Employment specialization index | 0.2661 | 0.2514 | 0.0809 | 0.7295 | 0.0947 |

*Outcomes Variables*

Population. Many competitiveness studies measure population or its growth (e.g., Carlino and Mills, 1987; Carruthers and Mulligan, 2008; and Glaeser et al., 1995). If competitive regions are defined as "places where both companies and people want to locate and invest in" (Kitson et al., 2004, p. 997), then by definition, competitive regions have growing populations. Population data for all years is obtained from the US Census Bureau. Population data from the decennial census (Census Bureau, 1993, 2002a, 2002b) and the American Community Survey (Census Bureau, 2007a) is checked against annual population estimates from the Census Bureau (2006). Population growth rates are hypothesized to display convergence through a negative association with lagged (base year) population levels and a positive association with per capita income as people migrate to take advantage of high-income job opportunities (Carruthers and Mulligan, 2008; Glaeser et al., 1995).

Employment. People in the labor force want to locate where they can find jobs. Following Carlino and Mills (1987), Carruthers and Mulligan (2008), the Corporation for Enterprise Development (2007), and Eberts et al. (2006), employment is an outcome measure of this study. Employment counts are obtained from County Business Patterns data so that employment can be compared to the number and size of establishments (Census Bureau, 2008a). In the Carruthers-Mulligan model, employment and population are also explanatory variables, and they are expected to have positive effects on each other (Carlino and Mills, 1987; Carruthers and Mulligan, 2008).[49]

Per capita income. The third outcome measure is per capita income, which measures productivity and the quality of life aspect of competitiveness (Eberts et al., 2006; Glaeser et al., 1995). Income data are obtained from the decennial census and the American Community Survey (Census Bureau, 1993, 2002b, 2007a).[50] The growth rate of per capita income reflects the effects of labor supply and demand on wages, and it is expected to be negatively related to population growth (potential labor supply) but positively related to employment growth (labor demand) (Carruthers and Mulligan, 2008).

*Innovation Input Variables*

Innovation is widely regarded as a driver of economic growth and competitiveness (Acs, 2002; Audretsch, 2002; Camp, 2005). Inputs to innovation include graduate students in science and engineering per 10,000 residents; PhD degrees awarded in science and engineering per 10,000 residents; academic research and development (R&D) funding per capita; college and graduate school enrollment; the percent of the population ages 25 or older with a graduate or professional degree; and the percent of employment in computer, science, and engineering occupations. Clearly, the innovation grouping has a large student component. Innovation inputs are expected to increase population growth as more students enroll in universities. However, students are not as likely to be in the labor market, so innovation is expected to have a negative relationship to employment growth. Researchers with advances economic degrees are skilled workers with relatively high earnings so innovation should be associated with increased per capita income growth.

Graduate Students and PhDs in Science and Engineering per 10,000 Residents. Science and engineering graduate students represent future sources of innovation and technology (Tuerck et al., 2008). Graduate students are also a measure of current university research efforts. Many graduate programs offer a master's degree but not a doctoral degree. The number of science and engineering doctorates awarded captures the quality of research performed and estimates future research capabilities. Data on science and engineering gradate students and Ph.D. awards is available from the National Science Foundation (1995, 1996, 2001, 2002b).

Academic R&D Spending per Capita. Academic institutions often undertake preliminary research and development (R&D) efforts that are cost-prohibitive for the private sector because results are not patentable but are crucial to future developments. Academic R&D efforts boost innovative activity in all firms, but academic R&D is especially important to innovation among small firms (Acs et al., 1994; Audretsch, 2002). Academic R&D spending is recorded by the National Science Foundation (1999, 2002a).[51]

College and Graduate Enrollment per 10,000 Residents. Undergraduate and graduate students make up the educated workforce of the future. A region's student population is its future base of knowledge workers. In addition, students often work on research projects that may benefit industry. Data on educational enrollment is obtained from the US Census Bureau (1993, 2002b).

Graduate Degree Attainment. Attainment of graduate and professional degrees is evidence of the critical thinking and research skills crucial to the knowledge economy.

Graduate degree attainment is expected to contribute to greater income growth as higher education is rewarded with higher earnings (Katz and Murphy, 1991). The percent of the population ages 25 and over that has attained a graduate or professional degree is available from the educational attainment tables provided by the US Census Bureau (1993, 2002b).

Percent of Employment in Computer, Science, and Engineering Occupations. Computer technicians, engineers, and scientists are responsible for many inventions and innovations, and the availability of these individuals is a proxy for private industry R&D activity. Several indices use the employment of computer technicians, engineers, and scientists as a measure of the New Economy (Atkinson and Correa, 2007) or workforce development (Indiana, 2007). An MSA's percent of employment in these occupations (Standard Occupational Classification [SOC] codes 15, 17, and 19) is calculated from US Census Bureau (1993, 2002b) data.

*Knowledge Workers Variables*

Knowledge workers are highly-educated people in creative occupations (Florida, 2002a, 2002b). Florida proposes that knowledge workers stimulate economic growth by starting businesses and by attracting other high-skilled workers. Variables in the knowledge workers grouping include the percent of employment in computer, science, and engineering occupations (discussed with the innovation inputs); the percent of people employed in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations; the percent of employment in professional, scientific, and technical industries; the percent of the population older than age 25 with a bachelor's degree; the percent of the labor force in the manufacturing sector; and the percent of the population older than age 25 with less than a high school diploma. The last two variables are expected to have a negative relationship to the other variables in the knowledge workers grouping. Knowledge workers are expected to have a positive effect on the growth rates of per capita income, employment, and population.

Creative Class. People employed in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations make up what Richard Florida (2002b) calls the "creative class" and what Drucker (1969, 1995) and Machlup (1962) call "knowledge workers." The percent of an MSA's employment in these knowledge- and creativity-intensive occupations is calculated from US Census Bureau (1993, 2002b) data.

Percent of Employment in Professional, Scientific, and Technical Services. Jobs in professional and technical occupations grew 68 percent faster than overall employment from 1999 to 2005 (Atkinson and Correa, 2007). Workers in professional, scientific, and technical services industries (North American Industrial Classification System [NAICS] code 541) generate and use the innovations and technologies associated with regional growth. In addition, some professional and technical employees perform business services (e.g., advertising, human resources, and legal services) that help propel the growth of other small businesses (Huovari et al., 2001). Census Bureau data (1993, 2002b) are used to measure each MSA's proportion of professional, scientific, and technical workers.

Percent of Employment in Manufacturing Industries. Service industries have taken the place of manufacturing in driving the US economy. Cities with large manufacturing bases have struggled to adopt new technologies and business paradigms (e.g., Detroit, Michigan, and Cleveland, Ohio, in the Rust Belt [Zumbrun, 2008]), and new industries have developed away from old manufacturing hubs (Audretsch, 2002; Markusen 1991, 1996; Martin and Sunley, 1998). Data on employment by two-digit NAICS industry is available from the US Census Bureau (1993, 2002b)

Bachelor's Degree Attainment. Educational attainment is a common measure of labor force skills (Lucas, 1988; Romer, 1990; Glaeser et al., 1995). In the New Economy, skilled labor is often more important to firms than is inexpensive labor (Malecki, 2004). Most professional and knowledge worker jobs require at least a bachelor's degree, and attainment of a college education is associated with higher wages and incomes (Katz and Murphy, 1991). Eberts et al. (2006) find that the skill-level of the labor force is the strongest indicator of per capita income. The percentage of the population over the age of 25 with a bachelor's degree is estimated from Census Bureau educational attainment data (Census Bureau, 1993, 2002b).

Persons with Less than a High School Diploma. Persons with less than a high school education are largely excluded from the knowledge economy. Furthermore, Florida (2002b) explains that the creative class is attracted to areas with amenities that lower-skilled workers are unable to afford. Consequently, the presence of an undereducated population may discourage knowledge workers from locating in a region, thus slowing the growth of population, employment, and income. The US Census Bureau (1993, 2002b) provides data on education attainment.

Patents per 10,000 Workers. Innovative activity is a hallmark of the New Economy (Acs, 2002; Audretsch, 2002; Camagni, 2002a). Within regional rankings and indices, patents can be construed as either an input or an output. Fisher (2005) considers patents an output measure. Jaffe et al. (1993) find patents are inputs to local knowledge and production because they are more frequently cited within the patenting region than in other regions. Patents serve as a proxy for both public and private innovation, and patent data is obtained from the Cluster Mapping Project (Harvard Business School, 2008).

Average Venture Capital Investments per Capita. Venture capital is an important source of financial capital for entrepreneurial firms, and a region's ability to attract venture capital gives it a competitive advantage over other regions (Devol et al, 2007; Zhang, 2003). Access to capital demonstrates that investors believe that a firm's products or services are marketable (Austrian et al., 2007). Venture capital data are expected to a show a positive relationship to employment growth, as found by Atkinson and Correa and per capita income growth, as found by Austrian et al. (2007). Venture capital data are obtained from PricewaterhouseCoopers (2007). Not all MSAs received venture capital in a given year, so venture capital data is averaged from 2000 to 2002. Several MSAs received no venture capital over the study period.

*Labor Employability Variables*

In the New Economy, skilled labor is often more important to firms than is inexpensive labor (Malecki, 2004). Eberts et al. (2006), Tuerck et al. (2007b, 2008), and others recognize the importance of labor force participation, employment rates, and labor skills in promoting economic growth. The labor employability variables include the percent of the population ages 25 and older with less than a high school diploma (discussed with the knowledge workers variables); the percent of the population ages 25-64; the labor force participation rate; the employment rate; the percent of the population who speak English well; and the percent of the population who are not in poverty. Labor employability is expected to have a positive relationship the growth rate of per capita income as wages are driven up by tight labor supplies. However, employment and population growth rates are expected to slow because firms may avoid locations with tight labor markets.

Percent of Population Ages 25-64. People ages 25 to 64 make up the working-age population.[52] A higher percentage of working-age persons decreases the dependent-to-worker ratio and contributes to greater economic growth (Bloom et al., 2007). This proxy variable has the advantage of including persons of working age who are not actively seeking work but who might join the workforce given favorable employment conditions. Age data are obtained from US Census Bureau (1993, 2002b) population estimates.

Labor Force Participation. A greater working population relative to total population is thought to generate larger GDP growth (Bloom et al., 2007; Gardiner, 2003; Tuerck et al., 2007b, 2008). Greater output growth translates to greater employment and per capita income growth, and population growth is anticipated to result from increased regional incomes. The US Census Bureau (1993, 2002b) provides labor force participation data.

Employment Rate. A high unemployment rate is associated with lower economic growth (Glaeser et al., 1995). If people are unable to find work in one region, they may move to another, reducing regional population and employment. Alternatively, they may stay in the area, which results in a lower per capita income. This study uses US Census Bureau (1993, 2002b) data to derive the employment rate:

$$\% \text{ employed} = 1 - \% \text{ unemployed}. \tag{3.52}$$

The employment rate rather than the unemployment rate is used to keep variable values positive, thus simplifying the interpretation and comparison of estimated coefficients.

Percent of Population that Speaks English Well. Different cultures have different relationships to education, business, and community involvement. Immigrants bring new business and communication patterns and new ideas to a region (Alesina and La Ferrara, 2005). However, some immigrants find it difficult to communicate and conduct their work in English. This difficulty can persist for additional generations if English is not the primary language in the home. Many indices include a measure of foreign-born residents (Eberts et al., 2006; Tuerck et al., 2007a, 2007b, 2008), but this study focuses on the communication aspect of ethnic and cultural diversity.

Out-of-Poverty Rate. Economic outcomes tend to be persistent. Regions with high poverty rates often struggle to increase resident's incomes, and discouraged residents may lack the resources to invest in higher education, skill upgrading, or new businesses.

Conversely, residents of more prosperous places are more likely to have the resources to invest in education and entrepreneurship. Furthermore, people are more likely to migrate to prosperous places. Out-of-poverty rates are calculated from US Census Bureau (1993, 2002b) poverty tabulations.

*Entrepreneurial Environment Variables*

Entrepreneurship is an important component of economic development because local business owners are more likely to build supply linkages with other local businesses and to spend profits locally, thus enhancing multiplier effects (Barkley, 2001; Markusen, 1996). Small businesses also are an important source of employment opportunities and job growth. The entrepreneurial environment grouping includes the number of proprietors per capita, the ratio of proprietors' income to total earnings in the MSA, and the percent of the population that is considered a racial minority. Entrepreneurship is expected to be associated with higher employment and per capita income growth rates, but entrepreneurs are not expected to have a significant effect on population growth.

Number of Proprietors per Capita. An entrepreneurial culture accepts the risks involved in starting new businesses and provides resources to support new businesses. Austrian et al. (2007) use the number of proprietors per capita as a measure of entrepreneurial breadth. The Bureau of Economic Analysis (2008) publishes the number of proprietors in each MSA, and total population available from the Census Bureau (1993, 2002b).

Proprietors' Income as a Share of Total Earnings. A larger share of proprietors' income relative to total earnings indicates entrepreneurial depth, or small businesses that create a high level of value for the local economy (Low et al., 2005). Successful entrepreneurs create new small businesses that tend to have rapid growth in employment and earnings (Davis et al., 2008). Bureau of Economic Analysis (2008) tabulations of income by source are used to measure the effect of proprietors' income on economic outcomes.

Racial Minority Presence. A MSA's racial composition reflects its past industrial legacy, and different races and ethnic groups have different business cultures, skills, education levels, and birth rates (Alesina and La Ferrara, 2005; Garmise, 2006). Minorities often lack access to the human, financial, and social capital beneficial to operating small businesses (Fairlie and Robb, 2008; Robinson et al., 2004). Data from the US Census Bureau (1993, 2002b) are used to determine the proportions of minority residents in each Southern MSA.

*Establishment Age and Churning Variables*

Regions with a large proportion of young businesses are more likely to have higher productivity and more rapid employment growth rates (Davis et al., 2008; Steinle, 1992). The establishment age and churning variable grouping includes the percent of establishments fewer than five years old and a business churning measure (establishment births plus deaths as a percent of total establishments). Young establishments also are expected to have a positive association with per capita income growth rates, but there are no *ex ante* expectations about the relationship of young establishments to population growth rates.

Percent of Establishments Fewer than Five Years Old. Young firms and industries tend to develop away from older industrial hubs because changing technologies and processes often require different infrastructure (Audretsch, 2002; Markusen 1991, 1996; Martin and Sunley, 1998). Young businesses are also associated with rapid productivity and employment growth (Steinle, 1992; Davis et al., 2008). Establishment age by category (i.e., 0-4 years and 5-9 years) is available as a special tabulation by the Census Bureau (2008b).

Business Churning. Zhang (2003) finds that Silicon Valley' success is partly attributable to its high rate of firm spin-offs. Less productive firms close down and free resources for new, more productive start-up firms (Greene et al., 2007; Schumpeter, 1950). Schumpeter's creative destruction is measured by business churning in this study. Business churning is calculated as

$$\text{churning} = (\text{firm births} + \text{firm deaths})/\text{total firms}, \tag{3.53}$$

and data are obtained from the annual Statistics of US Businesses (Census Bureau, 2001b).

*Business Size and Competitiveness Variables*

Schaffer (2002) and Steinle (1992) find that regional economic growth is stronger when employment is spread across many smaller firms rather than concentrated in a few large firms. The presence of small businesses is measured by the number of establishments per employee and the percent of establishments with fewer than 20 employees. The business size and competitiveness variables are expected to be associated with increased growth in employment and per capita income. However, small businesses may be associated with lower population growth rates because small businesses may arise in response to a lack of other economic opportunities, a characteristic that discourages in-migration.

Establishments per Employee. A large number of small firms competing for labor can be expected to result in higher wages, better labor matches, and, consequently, higher productivity (Glaeser, 2003; Scorsone, 2002). Employment and establishment counts from County Business Patterns data (Census Bureau, 2008a) are used to estimate an MSA's ratio of establishments to employees (Shaffer, 2002; Steinle, 1992).

Percent of Establishments with Fewer than 20 Employees. While the establishments per employee variable measures the inverse of average firm size, the percent of establishments with fewer than 20 employees identifies prevalence of small businesses. Small businesses provide workers with a high level of exposure to many aspects of production and management, and employees of small businesses may gain the knowledge and experience needed to start spin-off companies. County Business Patterns data (Census Bureau, 2008a) provide a count of establishments by size.

*Industrial Specialization*

Industrial specialization provides agglomeration economies as firms take advantage of localization economies, labor pools, and knowledge spillovers. Consequently, specialization may indicate the presence of industry clusters. Alternatively, industrial diversity helps regions to survive business cycles and long-term shifts in economic activity (CFED, 2003; Dissart, 2003; Malecki, 2004). Diversity also allows firms to take advantage of urbanization economies (Barkley and Henry, 2001).

Krugman (1991) defines a region's industrial diversity as the inverse of the region's industry employment specialization.

In this study, industrial specialization ($SPEC_r$) is calculated using Krugman's employment index (Krugman, 1991):

$$SPEC_r = \sum_{i=1}^{n} \left| \frac{EMP_{i,r}}{EMP_r} - \frac{EMP_{i,US}}{EMP_{US}} \right|, \tag{3.54}$$

where $EMP_{i,r}$ and $EMP_r$ are industry $i$ employment in region $r$ and total employment in region $r$, respectively, and $EMP_{i,US}$ and $EMP_{US}$ are US employment in industry $i$ and total US employment. The Census Bureau provides industry employment data at the two-digit Standard Industrial Classification (SIC) level for 1990 (US Census Bureau, 1993) and at the two-digit North American Industrial Classification System (NAICS) level. The Census Bureau provides a bridge with which to convert the SIC values to their NAICS equivalents.[53] Industrial specialization is expected to be associated with slower population growth; however, there are no *ex ante* expectations for relationships between industrial specialization and the growth rates of employment or per capita income.

*Industrial Composition*

Industrial composition describes the types of industries that have traditionally sustained a region's economy. The relative wage within traded industries compares the average wages in a region's traded industries to the average wages in those same industries in the US. Data on average wages in traded sectors is provided by the Cluster Mapping Project at Harvard Business School (2008).

The relative wage is a proxy measure for regional productivity (DeVol et al., 2007) and the region's stage in the product and profit life cycles (Markusen, 1985). More rapid wage and employment growth is anticipated in industries characterized by relatively productive labor and early-stage production processes. In addition, Porter (2003b) recommends a focus on the traded sector because these basic industries play a considerable role in driving wages and, to a lesser degree, employment throughout all industries in the region. Each region's relative wage within its traded industries (*RelativeIndWage*$_r$) is estimated as

$$RelativeIndWage_r = \sum_i \frac{EMP_{i,r}}{EMP_r} * \frac{W_{i,r}}{W_{i,US}}, \tag{3.55}$$

where $EMP_{i,r}$ is employment in traded industry $i$ in region $r$, $EMP_r$ is employment in all traded industries in the region, $W_{i,r}$ is the average wage in industry $i$ in region $r$, and $W_{i,US}$ is the US average wage for industry $i$. If $RelativeIndWage_r$ is greater than one, then region $r$'s average wage in its traded industries is higher than the US average wage in those same industries. Regions with higher relative industry wages are hypothesized to be at earlier stages of their industries' product life cycles, and therefore high relative wages are predicted to be associated with higher growth rates of population, employment, and per capita income.

**Summary**

This goal of this study is to suggest appropriate weights for variables in indices of regional economic competitiveness. Two aspects of variable weighting are considered. In case one, regression analysis is used to test the hypothesis that policy inputs and industrial structure/legacy have different effects on different competitiveness outcomes. In case two, interaction terms between policy and legacy variables are added to the case one estimations to test the hypothesis that a region's industrial structure and legacy affect its response to policy inputs.

The conceptual and mathematical models provided in this chapter build on earlier models of regional competitiveness. A conceptual pyramid model based on Gardiner (2003) is created, and empirical models based on the Glaeser et al. and Carruthers-Mulligan model specifications are developed. This chapter describes the study area, data, and estimation procedures used to model regional competitiveness. The growth rates of population, employment, and per capita income are modeled as functions of lagged or base year outcome values and initial conditions representing policy inputs, and industrial structure/legacy effects. Policy inputs include innovation inputs, knowledge workers, labor employability, and entrepreneurial environment. Industrial structure and legacy variables include establishment age and churning, business size and competitiveness, industrial diversity and specialization, and industrial composition.

Chapter four provides the results of the empirical estimations of the Glaeser et al. and Carruthers-Mulligan models. The variables are first combined into groupings based on factor analysis. These variable groupings are used to estimate the relationships of the outcome variables (growth in population, employment, and per capita income) to base year outcomes and initial conditions. Interactions between the initial conditions are then included in the estimations to test the effects of a region's economic structure/legacy on policies intended to improve regional competitiveness.

# CHAPTER 4

# RESULTS

## Introduction

The models described in chapter three are estimated using factor analysis and regression analysis. The regression results indicate, first, that regional policy inputs affect economic outcomes (e.g., growth in population, employment, and per capita income) differently. Second, the interactions of policy variables with industrial structure and diversity measures indicate that a region's economic environment and industrial legacy influence the effectiveness of economic policies. The significance of interactions between policy inputs and industrial legacy measures suggests that policies may be location-specific or at least may not be equally applicable to all regions. Consequently, indices of competitiveness should not necessarily use similar variable weights for all regions.

Section two of this chapter describes the variable groupings obtained through factor analysis. Section three discusses the estimation results of the Glaeser et al. (1995) and Carruthers and Mulligan (2008) model specifications for metropolitan-level changes in population, employment, and per capita income. The three competitiveness indicators (population, employment, and per capita income growth rates for 2000-2006) respond differently to the explanatory variables (policy variables and industrial legacy controls) in both the Glaeser et al. and Carruthers-Mulligan model specifications, and differences between the two specifications are noted. Section four describes the estimation results for the regression models that include interaction terms between explanatory variables.

Estimation results for both the Glaeser et al. and the Carruthers-Mulligan models indicate that economic legacy plays a role in benchmarking competitiveness. Section five summarizes the chapter's principal findings.

## Factor Analysis Results

Variables that measure characteristics that are related to regional economic growth are identified through a review of previous studies of the determinants of metropolitan area development. Table 3.1 in the previous chapter lists the variables used in past studies, Table 3.2 lists the variables' data sources, and Table 3.3 provides the descriptive statistics for each variable. The variables are also listed in Table 4.1. Competitiveness outcome measures include growth rates in metropolitan area population, employment, and per capita income. Policy measures are defined as regional characteristics that can be influenced by regional policy decisions. Structure/legacy variables reflect the region's economic history and may influence the effectiveness of current and future economic development policies, but the structure/legacy variables themselves are difficult to change, at least in the short term.

Variables are measured in per capita form to prevent the large cities' values from overwhelming smaller cities' data. Policy and structure/legacy variables are standardized to a mean of zero and a standard deviation of one. Standardization facilitates the combination of variables with different measurement scales (e.g., dollars per person and establishments per employee) and prevents larger absolute values from dominating the analysis. Competitiveness outcome variables (the ratios of population, employment, and per capita income in 2006 to their 2000 values) are measured in log form and thus represent growth rates.

*Construction of Variable Groupings Based on Factor Analysis*

Several of the variables measure similar metropolitan area characteristics (e.g., innovation or labor employability), and therefore some of the variables are highly correlated. A high correlation between explanatory variables in a regression essentially leads to double-counting of the underlying community characteristic and unreliable regression results (Greene, 2003; Intriligator, 1978). Factor analysis is used to categorize variables into groupings, each with a common underlying characteristic called a factor. A composite measure made up of the variables with a common factor is used in the estimated regressions. The instability and imprecision of coefficients in the estimations are reduced because variable groupings have little or no correlation to each other.

The principal-factor method is used to group variables according to their squared correlation coefficients. Six factors are identified through evaluation of eigenvalues and scree tests in Stata, an econometrics program (StataCorp, 2005). A minimum eigenvalue of one provides factors that fit well with economic theory and previous research results, are interpretable, and are reasonably invariant to changes in variables and structure.[54] The factor pattern matrix is then rotated orthogonally (varimax rotation) to more easily identify variables with a single factor and to facilitate interpretation of the factors (Hatcher, 1994; Kim and Mueller, 1978).

Table 4.1 provides the rotated variable loadings from the factor analysis. The sign of a variable loading does not indicate the direction of the relationship of the variable to

Table. 4.1. Orthogonally Rotated Factor Loadings from Standardized Variables.

| | Factor | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7/8 |
| Variable Name | Innovation Inputs | Knowledge Workers | Labor Employability | Entrepreneurial Environment | Establishment Age and Churning | Business Size and Competitiveness | Independent Structure and Legacy Variables |
| Policy Variables | | | | | | | |
| Graduate students in science and engineering per 10,000 residents | 0.9761 | 0.0768 | -0.0292 | 0.0019 | 0.0042 | -0.0065 | 0.0404 |
| Science and engineering PhD's per 10,000 residents | 0.9685 | 0.0792 | -0.0189 | 0.0022 | 0.0086 | -0.0254 | 0.0546 |
| Academic R&D spending per capita | 0.9446 | 0.0914 | -0.005 | -0.0084 | 0.0213 | 0.0123 | 0.0987 |
| College and graduate school enrollment per 10,000 residents | 0.9285 | 0.1255 | -0.0719 | -0.0645 | -0.0405 | 0.0085 | 0.1111 |
| Percent of population ages 25+ with an advanced degree | 0.7906 | 0.4765 | 0.117 | 0.0083 | 0.0809 | 0.0671 | 0.1231 |
| Percent of employment in computer, science, and engineering occupations | 0.6251 | 0.6561 | 0.0296 | -0.0792 | -0.1278 | 0.0619 | 0.1514 |
| Percent of employment in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations | 0.3137 | 0.8923 | 0.0139 | 0.0354 | 0.2115 | -0.0595 | 0.0557 |
| Percent of employment in professional, scientific, and technical services industries | 0.062 | 0.8770 | 0.0558 | 0.2215 | 0.2030 | -0.0587 | 0.1302 |
| Percent of employment in manufacturing sectors | -0.0684 | -0.7031 | 0.2457 | -0.0177 | -0.1723 | 0.5164 | 0.1439 |
| Percent of population ages 25+ with a bachelor's degree | 0.3797 | 0.7503 | 0.2076 | 0.1588 | 0.2529 | 0.2730 | 0.0860 |
| Percent of population ages 25+ with less than a high school diploma | -0.1289 | -0.6769 | -0.5636 | 0.1210 | -0.0437 | 0.2365 | 0.1350 |
| Percent of population of working age (25-64) | -0.319 | 0.1568 | 0.5361 | 0.1105 | -0.0713 | 0.5305 | 0.2876 |
| Labor force participation rate | 0.1491 | 0.1274 | 0.5841 | -0.1184 | 0.1110 | 0.4986 | 0.3455 |
| Employment rate (employed/labor force) | 0.1334 | -0.0080 | 0.8536 | 0.0306 | 0.2140 | 0.1823 | 0.1736 |
| Percent of population who speak English well | 0.0545 | 0.0201 | 0.7072 | -0.1850 | -0.3915 | 0.0256 | 0.3083 |
| Out-of-poverty rate | -0.2064 | 0.0655 | 0.9329 | 0.0946 | 0.0774 | 0.0769 | 0.0619 |

Continued.

Table. 4.1. Orthogonally Rotated Factor Loadings from Standardized Variables, Continued.

| | Factor | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7/8 |
| Variable Name | Innovation Inputs | Knowledge Workers | Labor Employability | Entrepreneurial Environment | Establishment Age and Churning | Business Size and Competitiveness | Independent Structure and Legacy Variables |
| Policy Variables, continued. | | | | | | | |
| Number of proprietors per capita | 0.0271 | 0.2715 | 0.1896 | 0.7301 | -0.0185 | -0.034 | 0.3551 |
| Proprietors' income as a share of total earnings | -0.1348 | 0.1582 | -0.2585 | 0.7250 | -0.0290 | -0.1599 | 0.3380 |
| Percent of population that is a racial minority | -0.0082 | 0.3048 | -0.3034 | -0.4852 | 0.0278 | 0.2494 | 0.5166 |
| | | | | | | | |
| Economic Legacy Variables | | | | | | | |
| Percent of establishments less than five years old | 0.0062 | 0.2711 | 0.1447 | -0.0099 | 0.8438 | -0.1977 | 0.1543 |
| Business churning | -0.0289 | 0.3349 | 0.0229 | -0.0539 | 0.7857 | -0.2092 | 0.2224 |
| Establishments per employee | -0.0601 | 0.1651 | -0.1223 | 0.0930 | 0.2527 | -0.8720 | 0.1213 |
| Percent of establishments with fewer than 20 employees | -0.0164 | 0.0293 | -0.0437 | 0.1004 | 0.1141 | -0.8453 | 0.2593 |
| Employment specialization index | 0.2744 | -0.4631 | 0.0598 | 0.0257 | 0.2765 | -0.1504 | 0.6069 |
| Relative wage of occupations in traded industries | 0.0599 | 0.3603 | 0.2736 | 0.0984 | 0.0512 | 0.4224 | 0.6010 |

the factor. However, the signs of the loadings do indicate the relationships between variables in a factor. Different signs mean the variables affect the factor in opposite ways (Kim and Mueller, 1978). The reader should note that the data for all variables in Table 4.1 are for the year 1990.

The factor analysis sorts the metropolitan characteristics into eight variable groupings, each of which is discussed below. The first four groupings are regional characteristics that may be influenced by economic development initiatives (i.e., innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) and the last four groupings represent regional economic legacy and structural characteristics (i.e., establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage). Two variables, the industry specialization index and the relative industry wage, are not grouped with other regional characteristics. Both of these variables are considered measures of economic structure/legacy. The percent of employment in computer, science, and engineering occupations loads highly on groupings 1 and 2 (referred to as the innovation inputs and knowledge worker groupings). Similarly, the percent of population ages 25 and up with less than high a school diploma loads highly on groupings 2 and 3 (referred to as the knowledge worker and labor employability groupings).

Table 4.2 provides abbreviations and summary descriptions of the factors. The remainder of this section describes the variables that are included in each grouping. The variable loadings are provided in parenthesis to clarify the strength of relationships

Table. 4.2. Factor Names, Abbreviations, and Descriptions.

| Factor Name | Abbreviation | Description |
|---|---|---|
| Policy Input Factors | | |
| Innovation inputs | Innovation | Innovativeness embodied by academic research and current and future science and engineering workers |
| Knowledge workers | KnowledgeWorkers | Availability of creative, professional, scientific, and technical workers; absence of manufacturing and under-educated workers |
| Labor employability | LaborEmployability | Pool and utilization of workers with basic skills |
| Entrepreneurial environment | Entrepreneurship | Role of proprietors in metropolitan economy |
| Indepdendent Structure/Legacy Variables | | |
| Establishment age and churning | YoungEstablishments | Young establishments' ability to generate new ideas and encourage creative destruction |
| Business size and competitiveness | SmallBusinesses | Business size and competitive environment |
| Employment specialization index | IndustrialSpecialization | Herfindahl index of employment concentration across industries |
| Relative wage of occupations in traded industries | RelativeIndWage | Average traded wage in a region's industries relative to the average wage for those same industries nationally |

between variables and underlying factors and the direction of correlations between variables.

Innovation Inputs Factor. The innovation inputs factor combines six variables related to university research activity and advanced academic degrees, particularly in the science and engineering fields. Academic institutions often conduct research and development (R&D) at the early stages of product and process development, and thus academic R&D spending per capita (0.9446) is included in the innovation factor. The number of science and engineering graduate students per 10,000 residents (0.9761), the number of science and engineering doctorates awarded per 10,000 residents (0.9685), and college and graduate school enrollment per 10,000 residents (0.9285) also load on the factor. In addition to conducting research, graduate students represent the local pool of potential future R&D workers. Alternatively, the percent of the population ages 25 and older with a graduate or professional degree (0.7906) and the percent of employment in computer, science, and engineering occupations (0.6251) indicate the size of the current R&D workforce.

Knowledge Workers Factor. The knowledge workers factor is loaded positively with the percent of employment in computer, science, and engineering occupations (0.6561); the percent of employment in management, business/operations, finance, computers, math, architecture, engineering, sciences, law, education, healthcare, arts, design, entertainment, media, and high-end sales occupations (0.8923); the percent of employment in professional, scientific, and technical services industries (0.8770); and the percent of the population over the age of 25 with a bachelor's degree (0.7503). The percent of working age persons with less than a high school diploma (-0.6769) and the percent of employment in manufacturing industries (-0.7031) load negatively. The positive loadings of knowledge worker groups and negative loadings of undereducated and manufacturing workers indicate negative correlations between the new knowledge economy and the old manufacturing economy.

Labor Employability Factor. The labor employability factor includes the proportion of the population that is of working age (0.5361), the labor force participation rate (0.5841), the employment rate (0.8536), the percent of persons who speak English well (0.7072), and the percent of persons at or above the poverty level (0.9329). The percent of persons with less than a high school education (-0.5636) loads negatively on the factor, indicating that low levels of education are associated with lower employability of residents.

Entrepreneurial Environment Factor. The entrepreneurial environment factor includes positive loadings for the number of proprietors per capita (0.7301) and proprietors' income as a share of total earnings (0.7250). These variables may represent a regional tolerance for risk and a local business environment that is conducive to small businesses. The percent of the population that is a racial minority (-0.4852) loads negatively on the entrepreneurship factor.[55] This negative loading may reflect the fact that minorities often lack access to the human, financial, and social capital beneficial to operating small businesses. Thus, minorities are less likely to own businesses, and minority-owned businesses tend to be smaller and have lower earnings than other businesses (Fairlie and Robb, 2008; Robinson et al., 2004).

Establishment Age and Churning Factor. The establishment age and churning factor combines the percent of establishments that have been operating less than five years (0.8438) with the business churning variable (0.7857). Churning is the number of establishment births and deaths relative to the total number of establishments, and churning measures the Schumpeterian idea of creative destruction. The young establishments factor represents the environment for new businesses and start-ups in the region.

Business Size and Competitiveness Factor. The business size and competitiveness factor includes measures of the number of establishments per employees (-0.8720) and the percent of establishments with fewer than twenty employees (-0.8453). The "small business" factor measures the relative competition among area businesses and the potential of small businesses to grow and generate employment opportunities. A larger number of small establishments may provide for greater innovation in product and process developments and a better match between area labor skills and business labor needs.

Independent Structure/Legacy Variables. Two economic structure/legacy measures did not load heavily on any factory and are included as single variables in the competitiveness models. The Krugman (1991) employment specialization index is a Herfindahl index that measures the regional concentration of workers across industries (two-digit standard industrial codes [SIC]) relative to the national distribution. The industrial specialization variable measures the role of industrial concentration versus diversity in regional economic development. The relative wage of occupations in traded industries measures the productivity of regional industries relative to the national productivity in those same industries. A high value for the relative wage variable is hypothesized to reflect industry establishments in earlier stages of their product life cycles.

*Calculation of Factor Scores*

Variables within a grouping are weighted by dividing each of the selected factor loadings by the sum of all the variables that load high on the factor.[56] For example, in Table 4.3 the number of proprietors per capita has a variable loading of 0.7301, and the sum of the high loadings on the entrepreneurial environment factor is 0.9699 (0.7301 + 0.7250 – 0.4852). Thus the variable receives a weight of 0.7528 in the entrepreneurship factor (0.7301/0.9699). Likewise, proprietors' income as a share of total earnings has a weight of 0.7475, and the percent of the population that is a racial minority has a weight of -0.4852 in the entrepreneurship factor.

Table. 4.3. Calculation of Variables Weights in the Entrepreneurial Environment Factor.

| Entrepreneurial Environment Variables | Variable Loadings | Relative Weights |
|---|---|---|
| Number of proprietors per capita | 0.7301 | 0.7528 |
| Proprietors' income as a share of total earnings | 0.7250 | 0.7475 |
| Percent of population that is a racial minority | -0.4852 | -0.5003 |
| Sum | 0.9699 | 1.0000 |

Each observation in the standardized data set is multiplied by the relative variable weights. The weighted variables are then summed to construct the factors. In Table 4.4, the entrepreneurial environment factor scores for three cities are calculated using the

Table. 4.4. Calculation of Entrepreneurial Environment Factor Scores for Selected Cities.

| | | Low Standardized Values (Hinesville-Fort Stewart, GA) | | Near-Average Standardized Values (Chattanooga, TN) | | High Standardized Values (Midland, TX) | |
|---|---|---|---|---|---|---|---|
| Entrepreneurial Environment Variables | Relative Weights | Standardized Values | Weighted Values | Standardized Values | Weighted Values | Standardized Values | Weighted Values |
| Number of proprietors per capita | 0.7528 | -2.1983 | -1.6548 | -0.1501 | -0.1130 | 4.8703 | 3.6662 |
| Proprietors' income as a share of total earnings | 0.7475 | -1.9403 | -1.4504 | -0.1717 | -0.1283 | 4.9599 | 3.7075 |
| Percent of population that is a racial minority | -0.5003 | 2.0493 | -1.0252 | -0.5445 | 0.2724 | -0.1912 | 0.0956 |
| Entrepreneurial environment factor score | | | -4.1304 | | 0.0311 | | 7.4693 |

weights constructed above. The table shows the values of standardized entrepreneurship variables for three cities. Hinesville-Fort Stewart, GA has values that produce below-average entrepreneurship scores; Chattanooga, TN has values near the mean; and Midland, TX has values that produce above-average scores. Each of the standardized values is multiplied by its respective weight, and the sum of those products is the factor score. All factor scores for each MSA and the descriptive statistics for the factor groupings in the study are provided in Appendix D.

Each factor has a mean of zero but the standard deviations range from 0.9231 for the innovation factor to 2.1433 for the knowledge factor. Most standard deviations are near one.[57] Fisher (2005) cautions that standardizing variables and then standardizing factors created from those variables can distort the variables' importance in determining outcomes. For example, a standardized variable in a standardized factor with six components carries only half the weight of a standardized variable in a standardized factor with three components. Furthermore, standardized factors with extremely high variable loadings have the same weight as factors with lower levels of communality among the selected variables. Variables in this study are standardized to facilitate the combination of disparate values into factors. However, the factors are not further standardized in an effort to preserve the relative importance of the variables to the underlying factor and therefore the importance of the factors to the competitiveness outcomes (Fisher, 2005; Johnson and Wichern, 2007). A one standard deviation increase in all variables included in a factor would cause the factor score to increase by one.

**Estimations of Regional Growth Models**

Appropriate variable weights for indices of competitiveness are suggested by regressing 2000 to 2006 population, employment, and per capita income growth rates on their own base year values and the variable groupings identified in the factor analysis. Case one of these estimations includes only the lagged outcome values, the four policy inputs (i.e., innovation inputs, knowledge workers, labor employability, and entrepreneurial environment), and the four structure/legacy measures (i.e., establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage). The results from the case one regressions test the hypothesis that variables affect each outcome differently.[58] A second set of estimations (case two) includes interaction terms between the policy and structure/legacy variables. Case one regressions of are estimated for both the Glaeser et al. (1995) and Carruthers-Mulligan (2008) model specifications. The separate equations model (Glaeser et al.) and the simultaneous systems model (Carruthers-Mulligan) are compared to determine the sensitivity of the results to the model specification selected.

The use of variables derived from factor analysis decreases the unreliability of regression coefficients caused by multicollinearity. Even so, the innovation inputs and knowledge workers factors are not included in the same regression due to high correlation between the factors.[59] One regression is run with the knowledge workers factor dropped, and another regression is run with the innovation factor dropped to simplify the model and distinguish the separate effects of the factors (Intriligator, 1978). The two models achieve consistent results.[60]

Potential correlation issues are further reduced by using year 2000 values of the lagged, or base year, outcome variables and 1990 values of the remaining explanatory variables, also called initial conditions. The use of 1990 values for the policy and structure/legacy variables also reduces the likelihood of endogeneity bias between explanatory variables (e.g., knowledge workers) and dependent variables (e.g., change in per capita income). Regressions estimated using year 2000 values for both the base year outcomes and the initial policy and structure/legacy conditions provide similar results.

Both the Glaeser et al. and Carruthers-Mulligan model specifications display heteroskedasticity in the employment growth estimations. Heteroskedasticity is also evident in the Carruthers-Mulligan estimation of population growth. Consequently, White-adjusted standard errors are used to determine the significance of the estimated coefficients.

*Glaeser et al. Model Estimation*

The Glaeser et al. model provided in Equations 3.32 through 3.34 was estimated using Stata (StataCorp, 2005). Table 4.5 provides the estimation results of the separate equations for growth in metropolitan area population, employment, and per capita income both when the knowledge worker factor is dropped from the regressions and when the innovation factor is dropped. The dependent variables in the Glaeser et al. model are the natural logs of the ratios of the 2006 to 2000 values of the competitiveness outcomes (population, employment, and per capita income).[61] The log of 2000 population, the standardized value of 2000 per capita income, and the groupings of the 1990 initial conditions identified by factor analysis are the explanatory variables.

Table 4.5. Estimation Results of Glaeser et al. Model Specification.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0296 ** | -0.0228 | 0.0103 | -0.0274 ** | -0.0180 | 0.0025 |
| | (-2.52) | (-1.45) | (1.46) | (-2.51) | (-1.22) | (0.35) |
| Per capita income, 2000 | 0.0162 * | 0.0227 ** | -0.0167 *** | 0.0173 * | 0.0241 ** | -0.0197 *** |
| | (1.73) | (2.08) | (-2.65) | (1.83) | (2.25) | (-3.39) |
| Innovation inputs factor, 1990 | 0.0014 | -0.0119 *** | 0.0096 * | -- | -- | -- |
| | (0.48) | (-3.61) | (1.72) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0027 | -0.0069 ** | 0.0107 *** |
| | | | | (-0.99) | (-2.07) | (3.81) |
| Labor employability factor, 1990 | -0.0094 | -0.0299 *** | 0.0177 *** | -0.0091 | -0.0279 *** | 0.0153 *** |
| | (-1.19) | (-3.50) | (3.20) | (-1.15) | (-3.31) | (2.80) |
| Entrepreneurial environment factor, 1990 | 0.0032 | -0.0011 | 0.0003 | 0.0031 | -0.0008 | 0.0001 |
| | (0.80) | (-0.24) | (0.08) | (0.79) | (-0.16) | (0.03) |
| Establishment age and churning factor, 1990 | 0.0699 *** | 0.0760 *** | -0.0012 | 0.0704 *** | 0.0777 *** | -0.0036 |
| | (6.84) | (5.58) | (-0.21) | (6.83) | (5.67) | (-0.64) |
| Business size and competitiveness factor, 1990 | -0.0216 *** | 0.0029 | 0.0313 *** | -0.0189 * | 0.0098 | 0.0206 *** |
| | (-3.52) | (0.36) | (4.89) | (-2.97) | (1.14) | (2.98) |
| Industrustial specialization, 1990 | -0.0059 | -0.0050 | -0.0069 | -0.0066 | -0.0095 | -0.0014 |
| | (-1.05) | (-0.65) | (-1.36) | (-1.14) | (-1.16) | (-0.28) |
| Relative industry wage, 1990 | -4.25E-05 | 0.0043 | 0.0010 | 0.0012 | 0.0060 | -0.0026 |
| | (-0.01) | (0.53) | (0.19) | (0.23) | (0.71) | (-0.49) |
| Constant | 0.4441 *** | 0.3764 * | 0.0253 | 0.4170 *** | 0.3168 * | 0.1235 |
| | (3.01) | (1.90) | (0.28) | (3.03) | (1.69) | (1.44) |
| Adjusted $R^2$ | 0.5237 | 0.5622 | 0.2028 | 0.5260 | 0.5611 | 0.2674 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

The estimated coefficient on base year population is interpreted as the percent change in the dependent variable associated with a one percent change in 2000 population, holding all else constant. For example, in the estimation of population growth using the innovation factor, population is expected to grow 0.0296 percent slower given a one percent increase in the 2000 metropolitan area population. The estimated coefficients on base year per capita income, industrial specialization, and relative industry wage (the standardized variables that are not grouped by the factor analysis) are interpreted as the percent change in the dependent variable associated with a one standard deviation change in the explanatory variable. For example, population is predicted to grow 0.0162 percent faster if 2000 per capita income is one standard deviation higher. The estimated coefficients on the policy and structure/legacy variable groupings (innovation, knowledge workers, labor employability, entrepreneurial environment, establishment age/churning, and business size/competitiveness) represent the percent change in the dependent variable if the factor score increases by one. For example, population is expected to grow 0.0216 percent faster if the business size and competitiveness grouping increases by one factor score.[62]

Coefficients on Lagged Outcome Variables. The results of the estimations are similar regardless of whether the innovation factor or the knowledge workers factor is included in the model. The logged base year population is significantly related only to metropolitan population growth rates. The base year per capita income is significantly related to all three outcomes. The signs of the estimated coefficients on population and income support Glaeser et al.'s (1995) findings of convergence among cities of different populations and income levels.[63] The log of 2000 population has negative relationships to population and employment growth and a positive relationship to growth in per capita income. Similarly, the base year per capita income has a negative association with per capita income growth and positive associations with population and employment growth. People appear to prefer locations with higher incomes but smaller populations.

Coefficients on Policy Input Variables. The estimation results show that the policy variables are related to the three competitiveness outcomes differently. The signs of the estimated coefficients on most of the policy factors (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) are expected based on previous studies. Both the innovation factor and the knowledge workers factor have a positive association with income growth but a negative correlation with employment. The innovation factor includes a large student component, and students are typically not employed. The negative relationship between the knowledge worker factor and employment growth indicates that knowledge workers provide economic development benefits primarily in terms of income growth and not job growth. This finding does not support Florida's (2002b) belief that the creative class attracts economic activity. Finally, a tight skilled labor market (as reflected in the labor employability factor) is associated with higher income growth but slower employment growth.

Coefficients on Industrial Structure/Legacy Variables. Only the businesses size/competitiveness (small business) factor and the establishment age/churning (young establishments) factor are significant among the structure/legacy variables. The small business factor has a significant negative relationship with population growth but a positive relationship with income growth. This suggests that a relatively large small-business sector is more relevant to growth in metropolitan per capita income than to growth in metropolitan size (population or jobs). Shaffer (2002) finds a similar relationship of small businesses to median household income. The establishment age/churning factor is significantly and positively associated with both population and employment growth. These results are consistent with Davis et al.'s (2008) finding that young businesses contribute to rapid employment growth.

*Carruthers-Mulligan Model Estimation*

The Carruthers-Mulligan model is a system of simultaneous equations based on the original Carlino-Mills model (1987). The simultaneous system acknowledges the inter-relationship between population and employment growth (i.e., the "chicken or the egg" phenomenon). The Carruthers-Mulligan model is estimated using two-stage least square (2SLS). The first stage estimates the two simultaneous outcome levels, and those predicted values are used in the second stage estimation of the change in the growth rate of population, employment, or income. For example, the 2SLS estimation of the change in the population growth rate (Equation 3.46) includes a first-stage estimation of the 2006 levels of employment and per capita income. The predicted 2006 employment and income values are then used to estimate the change in the population growth rate.[64]

The outcome variables in the Carruthers-Mulligan model are the natural log of the ratio of 2006 to 2000 population per square mile, the natural log of the ratio of 2006 to 2000 employment per square mile, and the natural log of the ratio of 2006 to 2000 per capita income.[65] Changes in each competitiveness outcome are attributable to the log of that outcome's base year level (not its change), the logs of the other two outcomes' current levels, and the vector of policy and structure/legacy variables. For example, the percent change in population density from 2000 to 2006 is a function of the log of the 2000 population density, the log of 2006 employment density, and the log of the 2006 per capita income, as well as the policy and structure/legacy variables.[66]

The estimation results of the Carruthers-Mulligan model with knowledge workers and innovation included separately in the regressions are shown in Table 4.6. The Carruthers-Mulligan model confirms results from the Glaeser et al. model indicating that policy and structure/legacy variables have different effects on the three competitiveness outcomes. For example, young establishments are relatively more important in predicting population and employment growth than growth in per capita income. The presence of knowledge workers appears to be more associated with income growth than with growth in metropolitan population or employment.

Most estimated coefficients in the Carruthers-Mulligan model have the same interpretation as coefficients in the Glaeser et al. model. The coefficient on the logged terms is interpreted as the percent change in the dependent variable given a one percent increase in the logged term, holding all else constant. The estimated coefficients on the other factors are interpreted as the percent change in the dependent variable if the factor increases by one factor score. For the coefficients on the industrial specialization and relative industry wage variables, a one factor score increase is equivalent to a one standard deviation change in the explanatory variable.

Table 4.6. Estimation Results of Carruthers-Mulligan Model Specification.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8971 *** | -0.1820 * | -- | 0.8171 *** | -0.2094 ** |
| | | (12.05) | (-1.76) | | (11.71) | (-2.27) |
| Log population/sq. mile, 2000 | -0.6325 *** | -- | -- | -0.6140 *** | -- | -- |
| | (-18.38) | | | (-17.75) | | |
| Log employment/sq. mile, 2006 | 0.6354 *** | -- | 0.1834 * | 0.6179 *** | -- | 0.2076 ** |
| | (18.17) | | (1.76) | (17.55) | | (2.23) |
| Log employment/sq. mile, 2000 | -- | -0.9037 *** | -- | -- | -0.8241 *** | -- |
| | | (-12.10) | | | (-11.72) | |
| Per capita income, 2006 | -0.1486 *** | 0.2340 *** | -- | -0.1499 *** | 0.2755 *** | -- |
| | (-3.48) | (3.65) | | (-3.30) | (4.17) | |
| Per capita income, 2000 | -- | -- | -0.1406 ** | -- | -- | -0.1733 *** |
| | | | (-2.34) | | | (-3.02) |
| Innovation inputs factor, 1990 | -0.0086 *** | 0.0112 ** | 0.0071 | -- | -- | -- |
| | (-2.66) | (2.13) | (1.49) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0016 | -0.0031 | 0.0106 *** |
| | | | | (-0.80) | (-1.01) | (4.32) |
| Labor employability factor, 1990 | -0.0023 | 0.0006 | 0.0158 ** | -0.0010 | -0.0064 | 0.0153 ** |
| | (-0.45) | (0.07) | (2.46) | (-0.20) | (-0.82) | (2.53) |
| Entrepreneurial environment factor, 1990 | -0.0092 *** | 0.0148 *** | -0.0026 | -0.0085 *** | 0.0125 *** | -0.0033 |
| | (-4.37) | (4.44) | (-0.77) | (-4.02) | (3.87) | (-1.09) |
| Establishment age and churning factor, 1990 | 0.0225 *** | 0.0073 | 0.0019 | 0.0242 *** | 0.0133 * | -0.0030 |
| | (4.81) | (0.92) | (0.32) | (5.07) | (1.68) | (-0.53) |
| Business size and competitiveness factor, 1990 | 0.0195 *** | -0.0329 *** | 0.0328 *** | 0.0204 *** | -0.0289 *** | 0.0254 *** |
| | (4.27) | (-4.53) | (4.95) | (4.36) | (-3.83) | (3.87) |
| Industrustial specialization, 1990 | 0.0017 | -0.0003 | -0.0101 ** | -0.0006 | 0.0005 | -0.0026 |
| | (0.55) | (-0.07) | (-2.38) | (-0.18) | (0.11) | (-0.62) |
| Relative industry wage, 1990 | -0.0056 | 0.0047 | 0.0026 | -0.0054 | 0.0059 | -0.0035 |
| | (-1.55) | (0.85) | (0.51) | (-1.46) | (1.05) | (-0.70) |
| Constant | 2.0043 *** | -3.0174 *** | 1.6768 *** | 1.9994 *** | -3.3589 *** | 2.0345 *** |
| | (4.70) | (-4.69) | (2.70) | (4.38) | (-5.07) | (3.45) |
| "$R^2$" | 0.8340 | 0.7635 | 0.2387 | 0.8299 | 0.7646 | 0.3147 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Coefficients on Lagged and Simultaneous Outcome Variables. The estimated coefficients on the base year outcome variables have the same signs as found by Carruthers and Mulligan (2008). Growth in population density is positively associated with current employment density and negatively associated with the base year population density and current per capita income. Growth in employment density is positively correlated with current population density and income and negatively correlated with base year employment density. Per capita income growth is positively associated with current employment density and negatively associated with current population density and base year per capita income, although only the coefficient on lagged income is statistically significant. The negative and significant coefficients on the lagged dependent variables in each equation support the regional convergence hypothesis, and the coefficients are consistent with the earlier findings for the Glaeser et al. model specification.

The base year per capita income is negatively related to income growth rates in both the Glaeser et al. and Carruthers-Mulligan models. Base year population density also is negatively related to population growth in both models. However, the inclusion of current as well as lagged outcomes in the simultaneous system and the inclusion of employment density as an explanatory variable result in sign changes between the Glaeser et al. and Carruthers-Mulligan models. For example, in the Glaeser et al. model of population growth, the estimated coefficient on the initial income level is positive and significant at the 10 percent level. The Carruthers-Mulligan simultaneous system includes the current per capita income in the population growth regression, and current income has a negative relationship to population growth that is significant at the one percent level.

Coefficients on Policy Input Variables. The Carruthers-Mulligan simultaneous system model produces a greater number of significant policy and legacy variables than does the Glaeser et al. separate equations model. All policy and legacy/structure variables in the Carruthers-Mulligan model are significantly associated with at least one outcome measure. Overall, the Carruthers-Mulligan model produces stronger significance of estimated coefficients. The simultaneous system captures relationships in different ways than does the separate equations model. Variables influence each outcome individually, and the outcomes influence each other. This systems approach changes the signs and significance of some of the estimated coefficients between the Glaeser et al. and Carruthers-Mulligan models. For example, the innovation factor has a significant negative association with population growth and a significant positive relationship to employment growth in the Carruthers-Mulligan specification. The estimated innovation coefficients in the Glaeser et al. population and employment regressions have signs opposite those of the Carruthers-Mulligan model. However, income growth rates are positively associated with innovation and knowledge workers in both the Glaeser et al. and Carruthers-Mulligan models.

As in the Glaeser et al. model specification, the estimations including the innovation factor and the knowledge workers factor produce similar results for the policy variables (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment). The innovation factor is associated with slower population growth and faster employment growth. Knowledge workers have a significant positive relationship to income growth, but there is not a significant correlation with employment growth such as is found in the Glaeser et al. specification. The labor employability factor is positively related to income growth, which is consistent with results from the Glaeser et al. model. Entrepreneurship has a significant positive association with employment growth and a negative association with population growth in the Carruthers-Mulligan specification whereas no estimated coefficients on entrepreneurship are significant in the Glaeser et al. model.

Coefficients on Industrial Structure/Legacy Variables. The business size/competitiveness (small business) factor is the most highly significant legacy variable. A larger presence of small businesses has a positive and significant association with the growth rates in population and per capita income and a negative and significant association with employment growth. Young establishments and churning have positive and significant correlation with population growth rates. In the version of the model with the innovation factor, industrial specification has a negative and significant relationship to income growth. The relative industry wage has no significant associations with the outcome measures.

**Effects of Variable Interactions on Competitiveness Outcomes**

Interaction terms between the policy and structure/legacy variables are added to the Glaeser et al. and Carruthers-Mulligan model specifications to determine if the industrial structure and legacy of a metropolitan area influence the relationships between the policy variables and area growth rates. In these “case two" estimations, interactions are added one at time to the case one regressions in order to preserve the degrees of freedom needed to calculate standard errors. The case two estimation results from both the Glaeser et al. and Carruthers-Mulligan models fail to reject the hypothesis that a region’s economic competitiveness is associated with its industrial structure and legacy. Most significant estimated coefficients on interaction terms occur between policy and legacy variables. A few significant interactions occur between two legacy variables. No interactions between two policy variables are significant. A significant estimated coefficient on an interaction term indicates that it may not be appropriate to use a single coefficient or “weight” on a policy variable for all regions included in an index of competitiveness.

*Glaeser et al. Model Interactions*

Case two estimations of the Glaeser et al. model include the interaction terms in separate equations for population growth, employment growth, and per capita income growth. In total, 21 equations were estimated to test for possible interactions among the explanatory variables. Table 4.7 provides the significant interactions terms in regressions that include the innovation factor or the knowledge workers factor. Coefficients on interaction terms are interpreted as the change in the dependent variable when both interacting terms deviate from their zero means by one factor score (or by one standard deviation in the case of the standardized variables for industrial specialization and relative industry wage). Note that regression coefficients on the stand-alone variables are not the same as the coefficients provided in Table 4.5 because inclusion of the interaction term in each regression changes other estimated coefficients. The full results of the estimations including significant interactions terms are available in Appendix E.[67]

An appreciation for the role of interaction terms on the interpretation given to changes in policy variables may be enhanced by reviewing the estimation results provided in Table 4.8. Assume, for example, suppose that a city's labor employability factor were to increase by one factor score in the Glaeser et al. model that includes innovation inputs. The growth rate of per capita income would be expected to increase by 0.0125 percent as a result of the tighter and more skilled labor market, as shown in Table 4.8. However, if the labor employability factor increased in a city with a business size/churning factor score one standard deviation above the mean, the expected income growth rate would increase by an additional 0.0109 percent as a result of the interaction. Consequently, the improved labor employability in the city with a relatively large number of small businesses would be associated with 0.0234 percent faster growth in metropolitan per capita income (0.0125 + 0.0109).

The interactions between policy and legacy variables can enhance or counteract the relationships of the single explanatory variables to the outcome measures (the growth rates of population, employment, and per capita income). For example, in the Glaeser et al. model estimations without interaction terms (case one) the labor employability factor has negative associations with employment growth and a positive association with per capita income growth (See Table 4.5). The negative interactions of the labor factor with small business/competition and industrial specialization increase the negative correlation between labor employability and growth in employment for metropolitan areas with (1)

Table 4.7. Significant Interaction Terms in the Glaeser et al. Model Specification.

| Factor | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Innovation x SmallBusinesses | -- | -- | -0.0119 * | -- | -- | -- |
| | | | (-1.95) | | | |
| KnowledgeWorkers x IndustrialSpecialization | -- | -- | -- | -- | -- | 0.0031 *** |
| | | | | | | (2.62) |
| LaborEmployability x SmallBusinesses | -0.0183 ** | -0.0202 ** | 0.0109 ** | -0.0176 ** | -0.0198 *** | 0.0091 * |
| | (-2.37) | (-2.57) | (1.94) | (-2.37) | (-2.66) | (1.79) |
| LaborEmployability x IndustrialSpecialization | -- | -0.0127 ** | -- | -- | -0.0110 ** | -- |
| | | (-2.01) | | | (-2.00) | |
| LaborEmployability x RelativeIndWage | 0.0085 ** | 0.0101 ** | -- | 0.0087 ** | 0.0103 ** | -- |
| | (1.98) | (2.24) | | (2.05) | (2.25) | |
| Entrepreneurship x SmallBusinesses | -0.0067 * | -- | 0.0046 * | -0.0065 * | -- | -- |
| | (-1.80) | | (1.77) | (-1.76) | | |
| Entrepreneurship x IndustrialSpecialization | -- | -- | 0.0074 *** | -- | -- | 0.0065 *** |
| | | | (3.82) | | | (3.77) |
| Entrepreneurship x YoungEstablishments | -- | -0.0129 ** | -- | -- | -0.0131 ** | -- |
| | | (-2.15) | | | (-2.23) | |
| SmallBusinesses x IndustrialSpecialization | -0.0083 ** | -- | 0.0054 * | -0.0074 * | -- | -- |
| | (-2.08) | | (1.79) | (-1.84) | | |
| SmallBusinesses x RelativeIndWage | -0.0116 ** | -- | -- | -0.0114 ** | -0.0118 * | -- |
| | (-2.50) | | | (-2.53) | (-1.68) | |
| IndustrialSpecialization x YoungEstablishments | -0.0169 *** | -- | 0.0065 * | -0.0166 *** | -- | -- |
| | (-2.84) | | (1.67) | (-2.80) | | |
| IndustrialSpecialization x RelativeIndWage | -- | -- | -0.0067 ** | -- | -- | -- |
| | | | (-2.01) | | | |
| RelativeIndWage x YoungEstablishments | -- | -- | -- | -- | -- | -0.0066 * |
| | | | | | | (-1.77) |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10. Interactions are included in the case one regression (see Table 4.3) one at a time.

Table 4.8. Example Interaction Between the Labor Employability and Business Size/Competitiveness Variables in the Glaeser et al. Per Capita Income Growth Model with the Innovation Inputs Factor.

| | $\ln(y_{06}/y_{00})$ |
|---|---|
| Log population, 2000 | 0.0123 * |
| | (1.76) |
| Per capita income, 2000 | -0.0167 ** |
| | (-2.43) |
| Innovation inputs factor, 1990 | 0.0088 * |
| | (1.73) |
| Labor employability factor, 1990 | 0.0125 * |
| | (1.90) |
| Entrepreneurial environment factor, 1990 | 0.0009 |
| | (0.28) |
| Establishment age and churning factor, 1990 | -0.0005 |
| | (-0.09) |
| Business size and competitiveness factor, 1990 | 0.0275 *** |
| | (4.10) |
| Industrustial specialization, 1990 | -0.0054 |
| | (-1.06) |
| Relative industry wage, 1990 | 0.0018 |
| | (0.33) |
| Labor employability, 1990 x Business size/competitiveness, 1990 | 0.0109 * |
| | (1.94) |
| Constant | 0.0034 |
| | (0.04) |
| Adjusted $R^2$ | 0.2726 |

Notes: The number of observations is 151; t-statististics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

relatively large numbers of small businesses and establishments per worker, and (2) relative specialized economic bases. Alternatively, the positive association between labor employability and income growth rates is stronger in metropolitan areas with larger shares of small businesses and a more competitive business environment (i.e., a high value for the business size/competitiveness factor). However, the estimated coefficient for the interaction of the labor employability factor with the relative industry wage is positive, and therefore, the labor employability factor's negative correlation to employment growth is reduced in areas with relatively high-wage labor.

Innovation, Knowledge Workers, and Structure/Legacy Interactions. Each of the policy factors (innovation, knowledge workers, labor employability, and entrepreneurial environment) interacts significantly with at least one structure/legacy variable. Innovation is associated with slower growth in per capita incomes in regions with large relative numbers of small businesses (as measured by the business size and competitiveness factor). Knowledge workers are correlated to faster income growth in regions with greater industrial specialization. In other words, per capita income grows faster when highly educated and creative people are able to collaborate within industry clusters.

Labor Employability and Structure/Legacy Interactions. The labor employability and business size/competitiveness policy factors exhibit the greatest interaction with legacy variables. The labor employability and small businesses factors interact significantly in estimations of all three competitiveness outcomes (the growth rates of population, employment, and per capita income). The negative estimated coefficients on the interaction in the population and employment growth regressions suggest that a tight skilled labor market has a more negative association with population and employment growth if a region has a relatively large number of small businesses (i.e., a high value for the business size and competitiveness factor). Alternatively, tight and skilled labor markets are associated with faster income growth in regions with high levels of competition among small businesses. That is, the demand for skilled, employable labor may be even stronger in regions with a relatively large number of small businesses.

Improved labor employability is associated with faster population and employment growth in regions with high relative industry wages. Relative industry wage is the proxy variable for labor productivity, thus the findings indicate that an increase in labor skills and employability has stronger growth impacts if the region's industrial base is concentrated in high productivity industries and establishments. Alternatively, the association between the labor employability factor and employment growth is reduced by an increase in regional industrial specialization. That is, the growth benefits associated with higher labor skills/employability will be less in a specialized regional economy (and greater in a diverse metropolitan economy).

Entrepreneurial Environment and Structure/Legacy Interactions. The negative coefficient on interaction term between the entrepreneurial environment and business size/competitiveness factors indicates that higher rates of entrepreneurship are associated with slower population growth in regions with smaller businesses. However, entrepreneurship is associated with a more positive relationship to income growth in regions with smaller businesses and relatively specialized industrial bases. Entrepreneurship is related to slower employment growth in regions with young establishments (as measured by the establishment age/churning factor). Consequently, improvements in the local entrepreneurial environment will have less positive associations with metropolitan employment growth in regions with relatively high concentrations of young businesses.

Interactions Between Structure/Legacy Variables. The structure/legacy variables (establishment age/churning, business size/competitiveness, industrial specialization, and relative industry wage) also interact with each other. Case one estimation results show that small businesses have a negative association with population growth but positive associations with growth in per capita income (refer to Table 4.5). In case two, the coefficients on interactions of business size with the structure/legacy variables are negative in the population change estimations but positive in the income growth equations. These findings indicate that the small business factor's negative association with population growth rates is more negative if the region has relatively high industrial specialization or industry wages. Alternatively, an increase in small business/ competitiveness will have a stronger positive association with regional income growth in areas with specialized industrial bases.

Neither industrial specialization nor relative industry wage are significantly related to regional growth rates in the case one estimations, but the variables interact significantly with establishment age/churning and each other. In general, industrial specialization or clustering has negative associations with population growth (and positive associations with per capita income growth) in regions with relatively young businesses. Finally, the estimated coefficients on the relative industry wage interaction terms (with the industry specialization and establishment age/churning variables) are negative in the income growth equation. A high relative industry wage (a proxy for labor productivity) has a less positive association with metropolitan area income growth if the region is economically specialized or has a large concentration of small establishments.

*Carruthers-Mulligan Model Interactions*

The significance of the interaction terms in the Carruthers-Mulligan model support the findings from the Glaeser et al. model and indicate that economic structure/legacy influences a region's response to policy inputs. Interactions may enhance or reverse the estimated coefficients on the stand-alone variables. Table 4.9 shows the significant interactions terms in estimations of the Carruthers-Mulligan model. The full estimation results for the regressions with significant interaction terms are provided in Appendix E. The estimated coefficients can be interpreted the same way in both the Glaeser et al. and the Carruthers-Mulligan models.

Case two of the Carruthers-Mulligan model produces many of the same significant interactions as the Glaeser et al. specification. The coefficients on these interaction terms have the same sign in both model specifications. One major difference between the specifications is that only two interactions affect population growth in the Carruthers-Mulligan model while several interactions influence population growth in the Glaeser et al. model. A second difference in the alternative specifications is that more interaction terms between the industrial structure/legacy variables are significantly related to employment growth rates in the Carruthers-Mulligan specifications. Differences in the

Table 4.9. Significant Interaction Terms in the Carruthers-Mulligan Model Specification.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| KnowWorkers x SmallBusinesses | -- | -- | -- | 0.0031 * | -0.0055 ** | -- |
| | | | | (1.72) | (-2.07) | |
| KnowWorkers x IndustrialSpecialization | -- | -- | -- | -- | -- | 0.0027 * |
| | | | | | | (1.94) |
| LaborEmployability x SmallBusinesses | -- | -0.0160 *** | 0.0138 ** | -- | -0.0161 *** | 0.0127 ** |
| | | (-2.76) | (2.47) | | (-2.78) | (2.42) |
| LaborEmployability x IndustrialSpecialization | -- | -0.0083 * | -- | -- | -0.0106 ** | -- |
| | | (-1.83) | | | (-2.42) | |
| Entrepreneurship x SmallBusinesses | -- | -0.0060 ** | 0.0053 * | -- | -0.0068 ** | 0.0044 * |
| | | (-2.05) | (1.96) | | (-2.35) | (1.68) |
| Entrepreneurship x IndustrialSpecialization | -- | -- | 0.0078 *** | -- | -0.0059 ** | 0.0074 *** |
| | | | (3.01) | | (-1.99) | (3.00) |
| Entrepreneurship x YoungEstablishments | 0.0048 ** | -0.0107 *** | -- | 0.0050 ** | -0.0121 *** | -- |
| | (2.35) | (-3.67) | | (2.38) | (-4.21) | |
| SmallBusinesses x IndustrialSpecialization | -- | -0.0068 * | 0.0062 * | -- | -- | -- |
| | | (-1.79) | (1.74) | | | |
| SmallBusinesses x RelativeIndWage | -0.0064 ** | -- | -- | -0.0070 ** | -- | -- |
| | (-2.07) | | | (-2.23) | | |
| IndustrialSpecialization x YoungEstablishments | -- | -0.0085 * | -- | -- | -0.0089 * | -- |
| | | (-1.69) | | | (-1.79) | |
| IndustrialSpecialization x RelativeIndWage | -- | 0.0075 * | -0.0086 ** | -- | -- | -- |
| | | (1.65) | (-1.96) | | | |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10. Interactions are included in the case two regression (see Table 4.6) one at a time.

significant interaction terms in Carruthers-Mulligan and Glaeser et al. specifications are noted below.

Knowledge Workers, and Structure/Legacy Interactions. Significant coefficients are produced when legacy variables interact with policy factor and other legacy variables. No interactions with the innovation inputs factor are significant in the Carruthers-Mulligan specification, whereas the interaction of the innovation and small businesses factors is significant and negative in the Glaeser et al. specification. The knowledge workers factor is associated with faster population growth in regions with high levels of small business competition (the business size and competitiveness factor). However, knowledge workers are associated with slower employment growth in regions with more small businesses. As in the Glaeser et al. model, the significant interaction between knowledge workers and industrial specialization indicates that an increase in knowledge workers is associated with faster growth in per capita income in regions with specialized industrial bases (e.g., industry clusters).

Labor Employability and Structure/Legacy Interactions. Labor employability interacts with the business size/competitiveness and industrial specialization factors in the same way as in the Glaeser et al. model. Improvements to labor employability are associated with slower employment growth if the region has a relative large number of small, clustered businesses. However, the labor employability factor is associated with faster income growth in regions with relatively large numbers of small businesses.

Entrepreneurial Environment and Structure/Legacy Interactions. The positive association between income growth and entrepreneurship is strengthened in regions with small businesses and industry specialization/clusters. These findings in the Carruthers-Mulligan estimations are consistent with the results of the Glaeser et al. model. However, these same interaction terms have negative effects on employment growth in the Carruthers-Mulligan specification. Small, locally-owned businesses in regional industry clusters promote income growth but slow employment growth. Likewise, entrepreneurship is related to slower employment growth in regions with relatively young establishments (as measured by the establishment age/churning factor), but, at the same time, entrepreneurship is associated with faster population growth in regions with young establishments.

Interactions Between Structure/Legacy Variables. Small business development is associated with slower employment growth but faster income growth in regions with a high degree of industrial specialization or clustering. Industry clusters in regions with high relative industry wages are associated with faster employment growth but slower income growth when the innovation factor is included in the Carruthers-Mulligan model. This result may demonstrate the effects of labor pooling within clusters. Labor matches are improved, and workers are willing to accept lower wages in return for the opportunities to change jobs without migrating and to interact with other people in their field. Finally, young establishments in industrially specialized regions are also associated with slower employment growth in the specifications of the model including either the innovation factor or the knowledge workers factor.

**Summary**

A review of previous studies suggests a number of regional economic characteristics that influence metropolitan competitiveness outcomes (e.g., population, employment, and per capita income). Data reflecting these characteristics are collected for 151 MSAs in the US South. Factor analysis is used to combine correlated variables into groupings with a common underlying characteristic, or factor. Four policy groupings (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) and four structure legacy groupings (establishment age/churning, business size/competitiveness, industrial specialization, and relative industry wage) are identified.

The groupings identified by factor analysis are included in estimations of the competitiveness outcomes on base year outcomes and initial conditions. The factor-based groups are uncorrelated with most other groups, which reduces correlation and endogeneity bias in the regression analysis. The use of year 2000 values for the base year outcomes and 1990 values for initial conditions further reduces the potential for correlation bias. The innovation and knowledge workers factor cannot be included in the same estimation due to correlation between the factors, but the two specifications produce similar estimation results.

The estimation results of both the Glaeser et al. and the Carruthers-Mulligan model specifications fail to reject the hypotheses of this study. The significance and coefficients of the variables change depending on the economic outcome (growth rates of population, employment, and per capita income) that is estimated. These results indicate that variables should be weighted differently in competitiveness indices, depending on how competitiveness is defined. In turn, this suggests that researchers should define what they mean by competitiveness before attempting to measure it. Additionally, the differences in the significance and coefficients in the Glaeser et al. and the Carruthers-Mulligan model specifications indicate that the empirical model used to benchmark regional economic competitiveness also influences the measured relationships between variables and, therefore, place rankings.

The significance of the estimated coefficients on the interaction terms in both the Glaeser et al. and the Carruthers-Mulligan model specifications indicates that policy variables interact with a region's economic structure/legacy to influence economic outcomes. Policy actions may filter though the region's economic environment, as suggested by the pyramid of competitiveness. In this case, cities may respond to economic policies differently, depending on their size or industrial base. Thus, it would be appropriate for the variable weights in competitiveness indices to vary by region.

# CHAPTER 5

# CONCLUSION

This study explores possible improvements to the methodology of benchmarking or indexing regional competitiveness. Variables representing economic characteristics believed to be related to regional competitiveness are selected based on reviews of previous studies, and data are collected for 151 metropolitan statistical areas (MSAs) in the Southern US Census region. Several variables measure similar concepts, so factor analysis is used to combine variables into uncorrelated variable groupings with common underlying factors, thus decreasing the potential for unreliable estimates. Two growth model specifications (Glaeser et al., 1995, and Carruthers and Mulligan, 2008) are used to estimate the relationships of the 2000 to 2006 growth rates of population, employment, and per capita income to the 2000 values of the lagged outcome measures and the 1990 values of the competitiveness inputs.

Two hypotheses are tested using regression analysis, and both fail to be rejected. First, variables reflecting regional competitiveness inputs (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) are shown to affect various outcome measures outcomes (growth rates of population, employment, and per capita income) differently. Coefficients on explanatory variables have different values and levels of significance in estimations of different competitiveness. Thus, in the construction of competitiveness indices, variables should be assigned a weight appropriate to their estimated effect on the specific competitiveness outcome measured by the index.

Second, policy inputs interact with a region's industrial structure and legacy (establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage) to influence competitiveness outcomes. Coefficients on interaction terms between several policy inputs and structure/legacy variables are significant. Consequently, policies intended to enhance regional economic competitiveness may have different effects in regions with different industrial structures and legacies. For example, improving labor employability by encouraging attainment of a high school diploma is expected to have a more positive effect on per capita income growth in regions with a relatively large number of small businesses. Therefore, it appears to be appropriate to weight variables differently across regions with different industrial structures and legacies.

**Summary of Findings**

Variables identified as important to regional economic competitiveness are identified through a review previous studies. Data are collected for 151 MSAs in the Southern US Census region for the period from 1990 to 2006 and variables are combined by factor analysis into four policy inputs and four industrial structure/legacy measures, each of which is composed of variables related by a common underlying factor. Policy inputs (innovation inputs, knowledge workers, labor employability, and entrepreneurial environment) can be affected by regional policies and economic development strategies, while industrial structure and legacy variables (establishment age and churning, business size and competitiveness, industrial specialization, and relative industry wage) are difficult to change in the short term because they reflect the history and composition of the regional economy.

The variable groupings identified by the factor analysis are generally statistically uncorrelated, and the groupings are used to reduce imprecision and instability in the estimations of selected competitiveness outcomes (the 2000 to 2006 growth rates of population, employment, and per capita income). However, the innovation inputs and knowledge workers factors remain correlated, and those two factors are not included in the same estimations.

Estimations of two specifications for regional growth models (Glaeser et al., 1995, and Carruthers and Mulligan, 2008) test the sensitivity of the results to the model specification. The two model specifications provide similar (but not identical) results in terms of significant coefficients for the policy and structure variables. However, both specifications support the first hypothesis that variables have different effects on different competitiveness outcomes. For example, both the innovation inputs and labor employability factors have a negative association with employment growth and a positive association with per capita income growth.

Both model specifications also support the second hypothesis that policy variables have different effects on metropolitan areas with different economic structures/legacies. For example, a high score for the labor employability factor is associated with slower growth of population and employment in regions with a relatively large number small businesses as measured by the business size/competitiveness factor. These findings indicate that (1) it may be appropriate to weight explanatory variables differently when measuring different competitiveness outcomes and (2) different weights may be appropriate for regions with different industrial structures/legacies. In addition, the empirical results appear to be sensitive to the specification of the growth model selected. For example, the entrepreneurial environment factor has a significant positive association with employment growth in the Carruthers-Mulligan specification, but entrepreneurship does not have a significant relationship with any outcomes in the Glaeser et al. specification. Thus, different underlying growth models can generate indices with different variable weights.

**Implications**

The conclusions of this study agree with previous studies (e.g., Camagni, 2002; Kitson et al., 2004; and Malecki, 2004) that regional economic competitiveness is a complicated process. It is unlikely that indices capture all of the intricacies of regional economies, and thus, these indices are unreliable indicators of competitiveness. While some published indices (e.g., Austrian et al., 2007, and Eberts et al., 2006) do measure different outcomes with different variable weights, most indices provide one set of variable weights to measure all competitive outcomes (e.g., Atkinson and Correa, 2007, and Tuerck et al., 2008). None of the reviewed indices include different weights for regions with different industrial structures and legacies.

The results of this study suggest that indices could be more reliable if they were less general, especially in cases where variables have estimated coefficients that are positive for one outcome and negative for another. For example, in the Glaeser et al. specification, relatively high labor employability has a positive association with the growth rate of per capita income but a negative association with the employment growth rate, so steps to improve labor employability (e.g., general education development or job-training programs) could aid the growth of regional per capita income but slow employment growth. Thus, it may be appropriate to provide multiple indices or at least sub-indices with different variable weights for different economic outcomes (e.g., changes in population, employment, and per capita income).

Furthermore, variable weights (based on regression coefficients' signs, values, and significance) appear to be sensitive to the economic growth model selected. In this study, small businesses (as measured by the business size and competitiveness factor) have negative relationship to population growth in the Glaeser et al. specification and a positive relationship to population growth in the Curruthers-Mulligan specification, and business size is significant in determining employment growth rates only in the Carruthers-Mulligan specification. Most researchers consider their methods to be proprietary and do not publish their growth model; however, providing the growth model would make variable weights more transparent and help policymakers to understand the differences between indices and the potential tradeoffs between competitiveness outcomes.

Finally, policy inputs appear to interact with a region's industrial structure and legacy to influence competitiveness outcomes. For example, improved labor employability has a more positive relationship to population and employment growth if the region has a relatively large number of small businesses. On the other hand, entrepreneurship has a less positive relationship to employment growth if a region has a relatively high number of young establishments. These findings indicate that policymakers should exercise caution in applying the economic development practices of successful regions to their own metropolitan area because policies could have different or even harmful effects, as suggested by Boschma (2004) and McCann (2004). Case studies of regions with similar economic structures and legacies are more appropriate, and researchers could aid these comparisons by grouping cities according to structural and historical characteristics, even if the underlying growth model does not include interaction terms. This goes a step beyond grouping cities by size (e.g., DeVol et al., 2007, and Eberts et al., 2006) and considers the historical and structural legacies of regional economies.

**Limitations**

Venture capital and patenting data are excluded from the study due to measurement error and correlation with other factors despite being identified as unique variables in the factor analysis. Many MSAs received no venture capital between 2000 and 2002 (PricewaterhouseCoopers, 2008), and data tabulated by consolidated metropolitan statistical area (CSA) cannot be accurately apportioned to the component

MSAs. The patent data also has missing observations for some MSAs (Harvard Business School, 2008). In addition, no adjustments are made for costs of living, again due to missing observations in quarters or, in some cases, over the entire study period (ACCRA, 2000, 2006). Attempts are made to replace missing data, but models estimated with unadjusted per capita income values are preferred to models relying on the manipulated adjusted data.

Similarly, the literature on regional competitiveness claims that locally-owned establishments are beneficial to regional economic development (Barkley, 2001; Markusen, 1996). Business ownership data is unavailable for this study; however, the exclusion of a measure of establishment ownership is not believed to introduce omitted variable bias because ownership is measured to some degree by the entrepreneurial environment and business size/competitiveness factors. Nevertheless, inclusion of ownership data would improve the growth models. Similarly, a more thorough accounting of industry size in each MSA would provide additional information on industrial structure because, for example, a region specialized in tourism will experience different growth patterns than a region specialized in high-tech enterprises.

The innovation inputs and knowledge workers factors from the factor analysis are correlated, thus producing unreliable results if the two factors are included in the same estimation (Greene, 2003; Intriligator, 1978). Consequently, the Glaeser et al. and Carruthers-Mulligan models are both estimated with the innovation inputs and knowledge workers factors included separately. Inclusion of the innovation inputs factor versus the knowledge workers factor affects the coefficients on all variables in the model, and coefficients have the same signs but different magnitudes and sometimes different significance. Therefore, the study does not identify the variable weights if measures of both innovation inputs and knowledge workers are included in a competitiveness index.

Population and employment, and thus the growth rates of these measures, are highly correlated. The error terms from the population and employment growth regressions are also correlated. This indicates that it may be appropriate to estimate the Glaeser et al. model specification using a seemingly unrelated regression technique. The Carruthers-Mulligan simultaneous system model could also be estimated with an error component.

**Recommendations for Further Research**

A natural extension of this research is to construct an index or indices of metropolitan competitiveness incorporating different variable weights for each of the three outcomes (growth in population, employment, and per capita income) as well as different weights for regions with different industrial structures and legacies. Index construction is complicated by three issues. First, because the model specification affects the variable coefficients and significance, a model on which to base variable weights must be selected. Second, the innovation inputs and knowledge worker factors do not appear in the same estimations, and discrepancies between the variable weights suggested by the regressions including each factor individually must be reconciled. Third, this study has not attempted to combine sub-indices for each of the three outcomes into a single index, and it is unlikely that the outcomes should be weighted equally in an index of overall competitiveness. Equally weighted outcomes would imply that a region that experienced greater population growth, maintained employment growth, but faced slower per capita income growth had maintained its competitive position over the study period. However, the slower per capita income growth indicates smaller improvements to regional productivity and quality of life by the end of the period.

Variables appear to have different effects on competitiveness outcomes, and therefore variable weights in competitiveness indices seem to be outcome-specific. Furthermore, it may be appropriate to weight variables differently in regions with different industrial structures and legacies. The combination of sub-indices for individual competitiveness outcomes (e.g., changes in population, employment, and per capita income) into a composite index of "competitiveness" appears to involve somewhat arbitrary weighting of the outcomes. As a result, indices are unlikely to capture the complexities of regional economic competitiveness, and they may even be misleading.

Researchers could elect to report only sub-index values for individual competitiveness outcomes (e.g., changes in population, employment, and per capita income). This would eliminate the need to weight and combine the outcomes into a composite index. Alternatively, researchers could report only raw data and explain what outcomes the variables are related to and how industrial structure/legacy characteristics influence policy inputs. This would allow policymakers to identify their metropolitan economy's strengths, weaknesses, and opportunities for growth, thus addressing the concern that competitiveness indices identify successful or lagging regions but not the reasons why these regions succeed or struggle (Dunning et al., 1998; Hall, 2007).

## ENDNOTES

1. The New Economy is generally accepted to be a knowledge-based economy, but researchers define the New Economy many ways (Atkinson and Court, 1998; Norton, 2000). It is often associated with computers and high-technology industries. However, traditional manufacturing establishments have adapted to the New Economy by using computer networks to manage supply, production, and distribution. The New Economy is believed to fuel unprecedented economic growth (Norton, 2000).
2. Porter (1998, 2002) does recognize the importance of standard of living in regional prosperity, but he insists that a region's standard of living is determined by its productivity.
3. A number of other authors (e.g., Huggins, 2003; Kitson et al., 2004) cite or adopt Storper's definition in their studies.
4. For example, both Budd and Hirmis (2004) and Martin and Sunley (2003) cite the Porter Diamond before developing their own conceptual models of competitiveness.
5. Gardiner et al. (2004) cite several sources for their competitiveness pyramid including Begg (1999), European Commission (1999), Jensen-Butler (1996), and Lengyel (2000, 2003).
6. Additional studies of innovation include Audretsch and Feldman (1996), Barkley et al. (2006a, 2006b), Ejermo (2005), and Feldman and Florida (1994).

7. See also Florida and Gates (2001).
8. Other authors also refute Florida's claims. Gabe (2006) finds that presence of a creative class does not correlate to greater future growth. Garmise (2006) and Gottlieb (2004) argue that labor markets are the determinants of regional growth, although they agree with Malecki (2003) and (Glaeser, 2005) that quality of life issues are important as well.
9. Acemoglu (1996), Becker et al. (1990), Fujita (2007), Gottlieb and Fogarty (2003), Mathur (1999), and Venables (1996) also study the effect of labor force education and skills on economic growth. Of course, the migration of workers also affects the relationship between education levels and regional competitiveness.
10. Other studies of the effect of entrepreneurship on regional economic growth include Acs et al. (2004), Chinitz (1961), Feldman and Francis (2004), Fairlie (2006), Lee et al. (2004), Mellinger et al. (2000), Minniti et al. (2004), and Saxenian (1999).
11. Many indices account for creative destruction with a business churning variable (Atkinson, 2002; Eberts et al., 2006). Business churning is defined as the sum of establishment births and deaths divided by the number of establishments in the region.
12. New firm employment growth rates are conditional on firm survival.
13. For addition work on the lock-in effects of industrial legacy and institutions, refer to Cortright (2001), Nitsch (2003), and Rauch (1993).
14. A region's institutions (e.g., laws, customs, organizations, and governing bodies) are also critical to its economic development. However, the role of institutions in

economic development is beyond the scope of this study. For more information on institutions, see Acemoglu et al. (2005), Coase (1998), Cortright (2001), Havrylyshyn and van Rooden (2000), Henderson and Wang (2007), Rodik et al. (2002), and Rychen and Zimmerman (2008).

15. The product cycle theory suggests that a sector or market expands rapidly following an innovation and then experiences slower growth as the market becomes saturated (Kuznets, 1930). Markusen (1985) develops the profit cycle theory by analyzing the profit levels that influence output decisions rather than the resultant output levels. Markusen theorizes that production is spatially concentrated in the early, innovative stages of the profit cycle, but production disperses to lower-cost regions in more mature stages.
16. Additional contributions to the literature regarding employment density (also called employment concentration) include Budd and Hirmis (2004), Ellison and Glaeser (1997), Enright (1993), Feser (2000), Glaeser (2000), Glaeser et al. (1992), Holmes (1995), Kim et al. (2000), Low et al. (2005), McCann (1995), the US Small Business Administration (1998), and Venebles (1994, 1996).
17. The interested reader may refer to Henderson (2003), Markusen (1996), and Saxenian (1994) for more information on the economic benefits of locally owned firms.
18. Unfortunately, business ownership data is not available for this study. Thus, the ownership structure of local establishments is not included among the regional characteristics in the conceptual and empirical models.

19. Additional research on industrial mix includes Garcia-Mila and McGuire (1993), Glaeser et al. (1992), Henderson et al. (1995), Hanson (2000), and Miracky (1995).
20. Additional research on clusters and agglomeration economies include Colgan and Baker (2003), Gordon and McCann (2005), Jacobs (1969), Marshall (1920), Porter (2000), Saxenian (1994), and Scott (1988).
21. For example, see Bellandi (1996), Parr (2002), and Penrose (1980).
22. Some indices focus on activity in the high wage, high growth technology industries (Devol et al., 2007; Gardiner, 2003; Huovari et al., 2001). The Cluster Mapping Project (Harvard Business School, 2008) identifies regional industry employment and mean wage relative to the national values. The project also tracks industry growth in regions and the nation.
23. In fact, Begg (1999) points out that competitiveness is frequently discussed in terms of an economy's traded sectors.
24. The interested reader is encouraged to refer to additional discussions of competitiveness, including Ciampi (1996), Cheshire and Gordon (1996), and Chien and Gordon (2007).
25. The full methodology of *The 1999 State New Economy Index* is not disclosed. The weights for each indicator are provided in an appendix. However, Atkinson et al. (1999) do not explain specifically how these weights are derived.
26. As is the case for other *New Economy* indices, the full methodology of *The 2007 State New Economy Index* is not disclosed. The weights for each indicator are provided in

an appendix. Atkinson and Correa (2007) do not explain how these weights are derived.

27. Eberts et al. (2006) select variables based on five themes that represent either aspects of economic growth or potential contributors to growth: economic growth and employment, education and workforce, equity and fairness, quality of life and place, and cooperation and governance. Most of the variables in their study correspond to these themes.
28. Eberts et al.'s (2006) skilled workforce factor includes both the educational attainment of the workforce and firms' ability to apply workers' skills, as measured by patents and the proportion of jobs in knowledge occupations. Two variables in the skilled labor force factor (bachelor's degrees and patents per employee) were more strongly correlated with output growth and productivity growth.
29. The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are grant programs administered by the US Small Business Administration.
30. The Grant Thornton *General Manufacturing Climates* study was first commissioned by the Illinois Manufacturing Association in 1978 and was published annually beginning in 1979. Grant Thornton based its ranking of state manufacturing climates on five categories: state and local governments' fiscal policies, state-regulated employment costs, labor costs, resource availability and productivity, and quality of life factors. Grant Thornton last published a *General Manufacturing Climates* report in 1993 (Malecki, 2004). However, Grant Thornton does publish annual *Great Lakes*

*Manufacturing* reports in cooperation with the Manufacturing Performance Institute (Grant Thornton, 2008). The 2008 *Great Lakes Manufacturing* report uses data from the Manufacturing Performance Institute's 2007 Census of Manufacturers.

31. Fisher (2005) critiques the Small Business and Entrepreneurship Council's Small Business Survival Index, the Tax Foundation's State Business Tax Climate Index, the Beacon Hill Institute's Metro Area and State Competitiveness Reports, the Cato Institute's Fiscal Policy Report Card on America's Governors, and the Pacific Research Institute's Economic Freedom Index.
32. Fisher (2005) evaluates *Economy.com*'s "North American Business Cost Review," *Expansion Management* magazine's six "quotients," and *Forbes'* "Best Places" rankings.
33. For example, the Beacon Hill Institute's mission statement references the organization's commitment to limited government, fiscal responsibility, and free markets (BHI, 2008).
34. Steinle (1992) insists that competitiveness be measured with multiple outcomes. Steinle uses the change in employment and growth in GDP per inhabitant as outcome measures. He regards both measures as important but claims that neither is an accurate indicator when used alone.
35. Glaeser et al. (1995) note the similarity of their finding of income convergence when controlling for education to the conditional convergence found by Barro (1991).

36. Employment growth is not part of the model presented by Glaeser et al. (1995). However, they regress employment measures on the explanatory variables used to predict growth in population and income.

37. Carlino and Mills (1987) found that median family income and median schooling could not be included in the same regression, probably because they are correlated with each other and perhaps with other independent variables. They chose to exclude the schooling variable. The coefficients on crimes rates were not reported due to instability, which Carlino and Mills attributed to the under-reporting of crimes.

38. For more information on the relationship between employment and population, see Blanchard and Katz (1992); Blanco (1963); Borts and Stein (1966), Mills and Price (1984), Muth (1971), Partridge and Rickman (2003), or Steinnes (1982).

39. Carlino and Mills (1987) also model the relationship between manufacturing employment density and population density, and they find that increasing population density reduces the density of manufacturing employment. They attribute this result to the declining relative importance of manufacturing in more densely populated regions.

40. Carruthers and Mulligan (2008) also draw from Bao et al. (2004); Boarnet (1994a, 1994b); Boarnet et al. (2005); Carruthers and Mulligan (2007); Carruthers and Vias (2005); Clark and Murphy (1996); Deller et al. (2001); Glavac et al. (1998); Henry et al. (1997, 1999, 2001); Mulligan et al. (1999); Mulligan and Vias (2006); Steinnes and Fisher (1974); and Vias and Mulligan (1999).

41. Carruthers and Mulligan (2008) also include a spatial lag term in their model, but the spatial component is not relevant to this study.

42. Rosenthal and Strange (2004) also establish a relationship between population and productivity (which is reflected in per capita incomes); they find that a doubling of population is associated with a 3-8 percent increase in city productivity. Steinle (1992) explains that employment growth tends to accompany the export expansion that generates rising incomes.

43. The lagged dependent variable is included in the $X$ vector of the Glaeser et al. (1995) model. Glaeser et al. use the log of lagged population in their regressions although their conceptual model identifies only level right-hand-side variables.

44. Glaeser et al. (1995) do not derive a theoretical model of employment; however, they do regress employment on the exogenous variables used to predict income and population. See Glaeser et al. (1995) Tables 4 and 5. Following Glaeser et al., employment is regressed on the log of lagged population and lagged per capita income, but employment is also regressed on the log of lagged employment and lagged per capita income. Additionally, variable symbols are changed to match the symbols used by Carruthers and Mulligan (2008).

45. The $\alpha$ and $\beta$ coefficients in Equations (3.28) and (3.30) replace Glaeser et al.'s $(\beta+\theta)$ and $(\delta\beta+\sigma\theta-\theta)$ coefficients multiplied by the constant $1/(1+\delta-\sigma)$, and the $\varepsilon$'s are error terms.

46. Alternatively, the vector may consist of a representative variable from each element of the pyramid.

47. Wilmington, DE-MD, is actually a metropolitan division within the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD, MSA, and Wilmington is not included in this study.

48. Enid, OK, was a metropolitan statistical area in 2000, but Enid became a micropolitan statistical area with the introduction of that designation in 2003. It is not a metropolitan statistical area in 2006 and is excluded from this study.

49. Eberts et al. (2006) note that the correlation between employment growth and population growth can also be associated with urban sprawl, and therefore population is not a good measure of regional competitiveness by itself.

50. The per capita income data are adjusted for cost of living differences between MSAs using the ACCRA (1990, 2000, 2006) cost of living tables. Not all cities report their cost of living in all fiscal quarters, so data from the nearest available quarter is substituted for missing values. Some cities never report cost of living information, and these observations are extrapolated from nearby cities' data. Consequently, measurement error is introduced to the adjusted income variables. Both adjusted and unadjusted per capita income values are included in model estimations.

51. Private R&D expenditures can be difficult to estimate, but industry R&D expenditures are included in some studies of competitiveness (e.g., Austrian et al., 2007). Alternatively, Gardiner (2003) and Huggins (2003) use the number of high-tech businesses as a measure of private innovative capacity.

52. Many studies consider the working-age population to be ages 16-64. However, high school and college age persons often do not work full-time. Young people are also less likely to contribute to the knowledge economy.

53. The North American Industrial Classification System (NAICS) replaced the Standard Industrial Classification (SIC) in 1997.

54. The selected factor structure is one of several possible structures. Other factors and other variables may be valid as predictors of competitiveness as well. In fact, patenting and venture capital data were initially included in the data set, but these variables were dropped due to measurement error (missing observations and MSA definitions that differ from the definitions of this study) and potential correlation with other variables despite high uniqueness scores. (The factor analysis did not group patents or venture capital with other variables.) After several factor analysis iterations, the six factors identified best meet the criteria of the statistical tests, the economic theory, and the structure of the data set.

55. Minority presence actually has greater uniqueness than communality with the entrepreneurial environment factor. However, the loadings are similar in magnitude and some factor structures (e.g., five factors instead of six) result in minority presence loading highest on the entrepreneurship factor. Consequently, the percent of minorities in the populations is included in the entrepreneurship factor to reduce collinearity issues.

56. Weighting variables by their share of the factor loadings is a transformation the factor scoring of the described by Johnson and Wichern (2007). Johnson and Wichern

suggest weighting each variable by its loading and then summing the weighted variables. Dividing each variable loading by the sum of the factor loadings preserves the relationships between loadings while providing scores that are smaller in magnitude and more similar to the standardize variable values.

57. The standard deviations of the factors are as follows: innovation inputs, 0.9231; knowledge workers, 2.1433; labor force availability and quality, 1.0692; entrepreneurial environment, 1.5490; percent young establishments and churning, 0.9590; and small establishment competition, 0.9518.
58. To simplify discussion of regression results, the term "variable" is used to refer both to the variable groupings identified through factor analysis and to variables excluded from factor groupings (e.g., the industrial specialization and traded wage variables and the lagged outcome measures).
59. Similarly, Carruthers and Mulligan (2008) included human capital and quality of life measures in separate regressions due to correlation between these initial conditions.
60. The other variables in the regressions maintain their signs and similar magnitudes in regardless of whether the innovation or knowledge workers variable is included in the model. However, the innovation and knowledge workers variables are significant only if the other factor is dropped from the estimation. The condition number for the estimation including both the innovation and knowledge workers factors is 24.79; the condition number for the estimation in which knowledge workers are dropped is 6.46.
61. Per capita income is not adjusted for cost of living in the reported estimations of either the Glaeser et al. and Carruthers-Mulligan specifications. The results of models

that relied on adjusted per capita income are not reported due to measurement errors arising from non-reporting cities.

62. As mentioned in the preceding section, a one unit change in the factor score would result from a one standard deviation change in each variable included in the factor.
63. Glaeser et al. (1995) found stronger evidence of income convergence than population convergence. Furthermore, the directions on the coefficients here more closely resemble the Glaeser et al. coefficients for cities than for metropolitan statistical areas.
64. The Carruthers-Mulligan model specification is also estimated using three-stage least squares (3SLS) approach. In 3SLS, specification errors in one equation can bias all outcomes because the third stage enables correlation between the error terms. The results of the 2SLS of 3SLS simultaneous system estimations are compared (1) to ordinary least squares (OLS) regressions (both standard and White-adjusted) of the outcomes on the initial conditions and actual values of the simultaneous level outcomes and (2) to White-adjusted 2SLS estimations in which only 2000 base year outcomes are included on the right-hand side of the stage one estimation. The results of all five estimation methods were reasonably similar. The 2SLS estimation of the simultaneous system produced coefficients and standard errors that were consistent with the alternative specifications. The 3SLS estimations produced coefficients that were larger in absolute value and slightly smaller standard errors.
65. The logs of the population and employment ratios used in the Glaeser et al. model are equivalent to the logs of the population density and employment density ratios in the

Carruthers-Mulligan model because the denominator (square miles) cancels out of the ratios.

66. Income variables are included in the Carruthers-Mulligan model in log form, so they are not standardized as in the Glaeser et al. model.
67. Coefficients and levels of significance change for the stand-alone variables when interaction terms are included in the models. In some cases, a stand alone variable becomes more significant when it is included in a significant interaction (e.g., the interaction of the entrepreneurship factor and the business size/competition factor causes the coefficient on the industrial specialization variable to become more significant in estimations of population growth). However, some variables become less significant when they are included in interaction terms (e.g., when the labor employability factor is interacted with the relative industry wage, the labor employability factor's coefficient loses significance in employment estimations).

# APPENDICES

## Appendix A: Models of Regional Competitiveness

*Variants of the Porter Diamond Model*

Several authors elaborate on the Porter Diamond to make relationships more obvious to readers. For example, while Porter (1998a) discusses the influence of government on each determinant of regional competitiveness, Value Based Management.net (2007) adds government as a fifth determinant affecting the other determinants in the diamond (Figure A.1). Similarly, 12 Manage: The Executive Fast Track (2007) make both government and chance explicit in their version of Porter's model (Figure A.2).

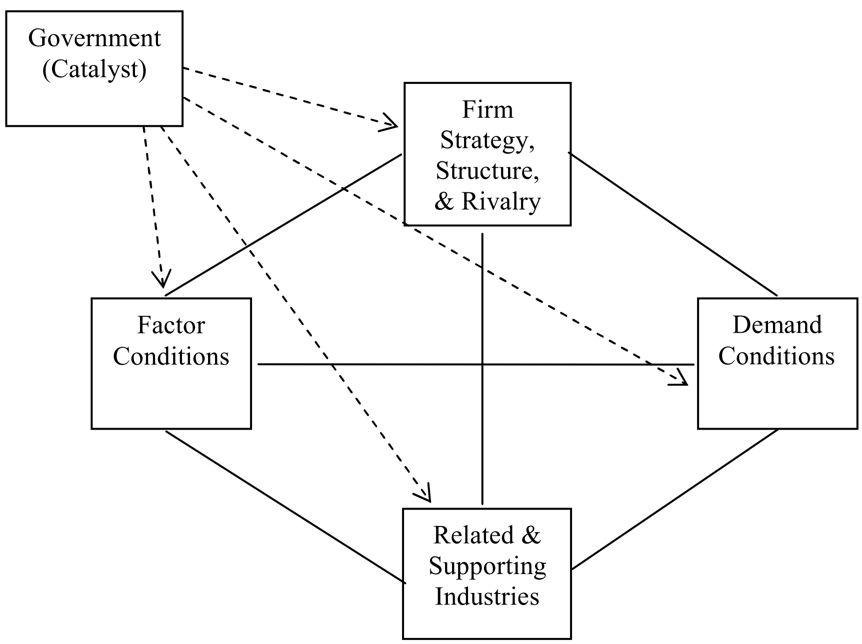


Figure A.1. Value Based Management.net (2007) adaptation of the Porter Diamond.

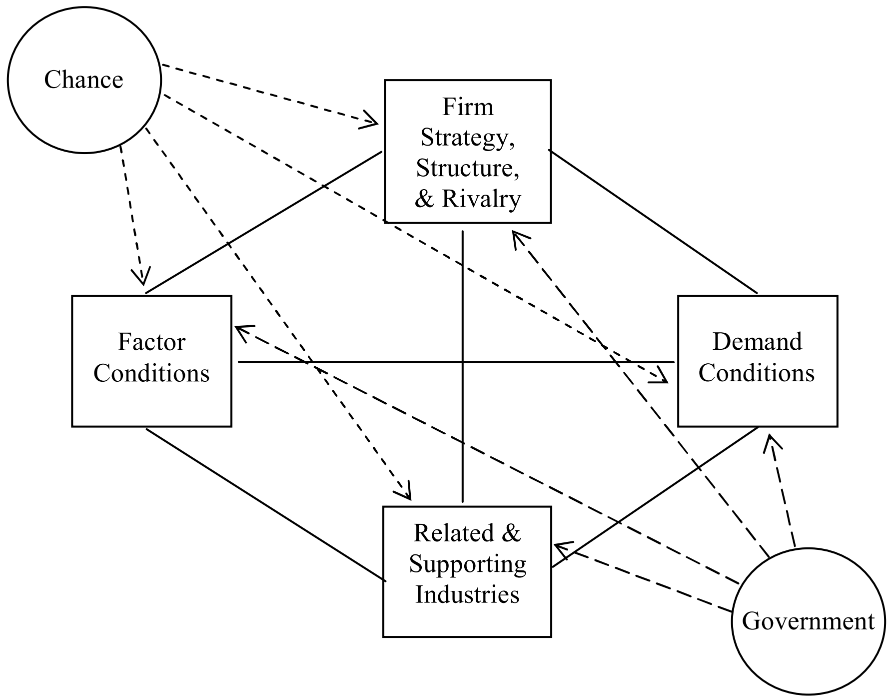


Figure A.2. 12 Manage: The Executive Fast Track (2007) adaptation of the Porter Diamond.

Kitson et al. (2004) expand Porter's framework to augment productive capital with additional types of capital as inputs to regional competitiveness. Figure A.3 shows the relationships of productive knowledge, infrastructural, cultural, social-institutional, and human capital both to each other and to regional competitiveness. All dimensions of competitiveness affect other dimensions. The Kitson et al. model explicitly identifies regional productivity, employment, and standard of living as competitiveness outputs. The additional input and output measures reflect the fact that Kitson et al. support a broader definition of competitiveness while Porter considers competitiveness equivalent to productivity.

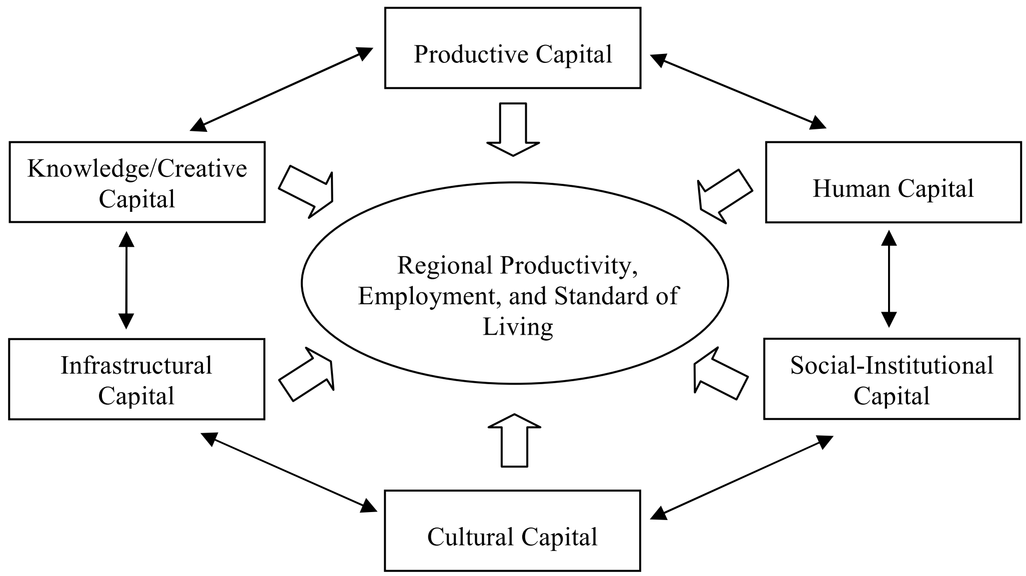


Figure A.3. Bases of competitive advantage (Kitson et al., 2004).

Gardiner (2003) provides a model similar to that of Kitson et al. (Figure A.4); however, Gardiner's model provides direct links to economic theories. Regional competitiveness results from inputs suggested by neoclassical economics, new growth theory, and economic geography, as well as inputs describing cost competitiveness and knowledge based factors. Unlike the Kitson et al. model, Gardiner's model does not allow for interaction between the determinants of competitiveness.

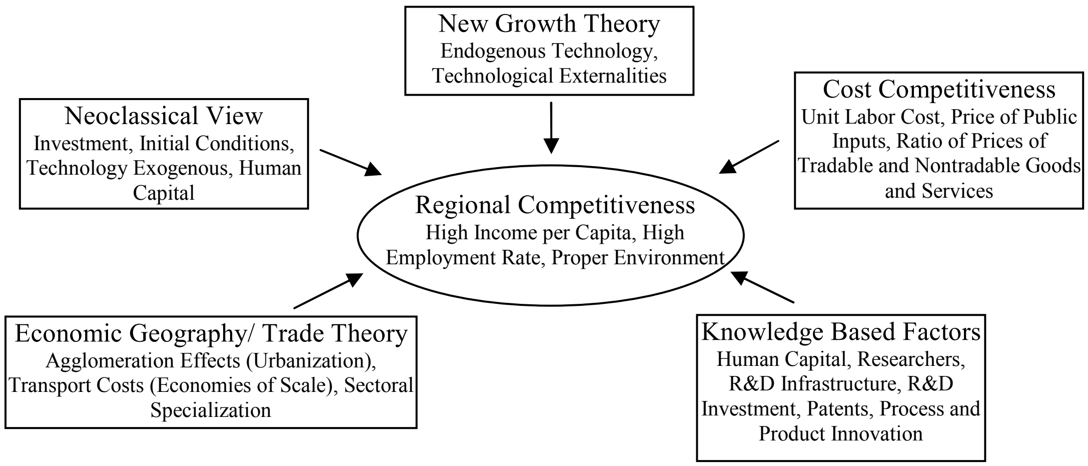


Figure A.4. Theoretical Aspects of Regional Competitiveness (Gardiner, 2003).

The Budd and Hirmis (2004) framework in Figure A.5 is also based on Porter's diamond. The Budd and Hirmis model combines regional competitive advantage with national comparative advantage to determine regional competitiveness, which they define as productivity. Efficient firms enhance firm-level productivity to promote the competitive advantage of the region. Similarly, firms that produce efficiently are more likely to have a comparative advantage in the world market. Competitive advantage and comparative advantage are further enforced by economies of regional production. Localization or urbanization economies are external economies of scale. Activity-complex economies represent linkages between firms and their competitors, collaborators, suppliers, and institutions. Urbanization economies foster diversity, the flow of ideas, and the ability to specialize production.

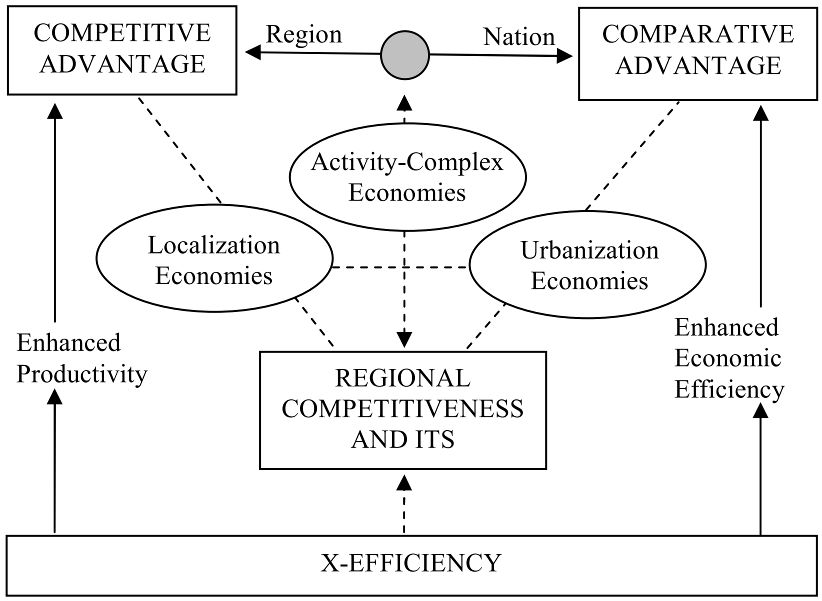


Figure A.5. Framework for assessing regional competitiveness capacity (Budd and Hirmis, 2004).

*Input-Output-Outcome (Hierarchical) Models*

Huggins' (2004) input-output-outcome model (Figure A.6) includes three factors used in his UK competitiveness index. Huggins models productivity as a function of business density, knowledge-based businesses, and economic participation. Productivity increases lead to higher earnings and lower unemployment.

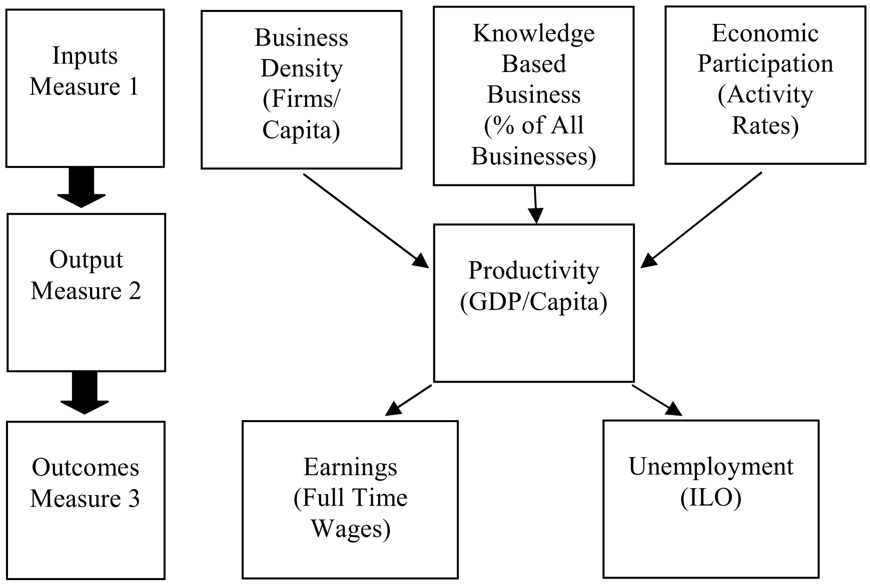


Figure A.6. Three-factor model for measuring local and regional competitiveness (Huggins, 2004).

Steinle (1992) divides competitiveness into two components: the dynamics of productivity (GDP per capita) and the dynamics of employment (Figure A.7). Both components are directly influenced by economic characteristics such as high quality or high value-added functions, export strength, and innovation capacity. These economic characteristics also affect sector dynamics. In turn, dynamics and characteristics of regional industries influence productivity and employment. Steinle also posits that regional competitiveness affects regional sensitivity, or the extent to which regions are affected by economic shocks. Steinle uses his conceptual model to measure the competitiveness of regions in the Single European Market.

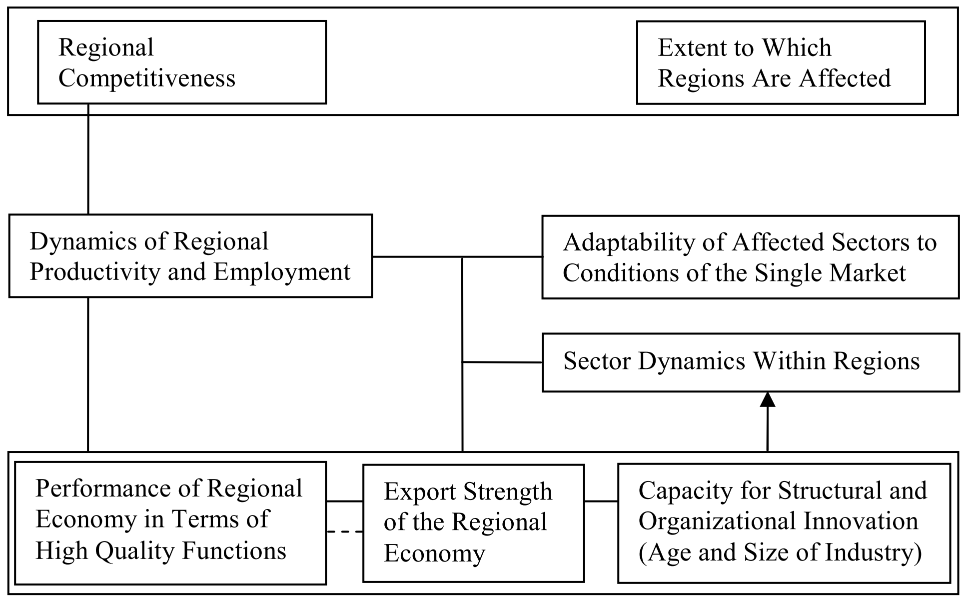


Figure A.7. Regional sensitivity and regional competitiveness model (Steinle, 1992).

*Pyramid Models*

Gardiner et al. (2004) cite Begg's (1999) model as a precursor of their pyramid model. However, Begg's model is not a clear pyramid; in fact Begg (1999, p. 802) calls his model the "urban competitiveness maze" (Figure A.8). Inputs such as sectoral trends, company characteristics, the business environment, and capacity for innovation influence the employment rate, productivity, and urban performance. These outcomes affect each other and the region's standard of living. Begg's model also includes a feedback mechanism by which the standard of living affects urban performance.

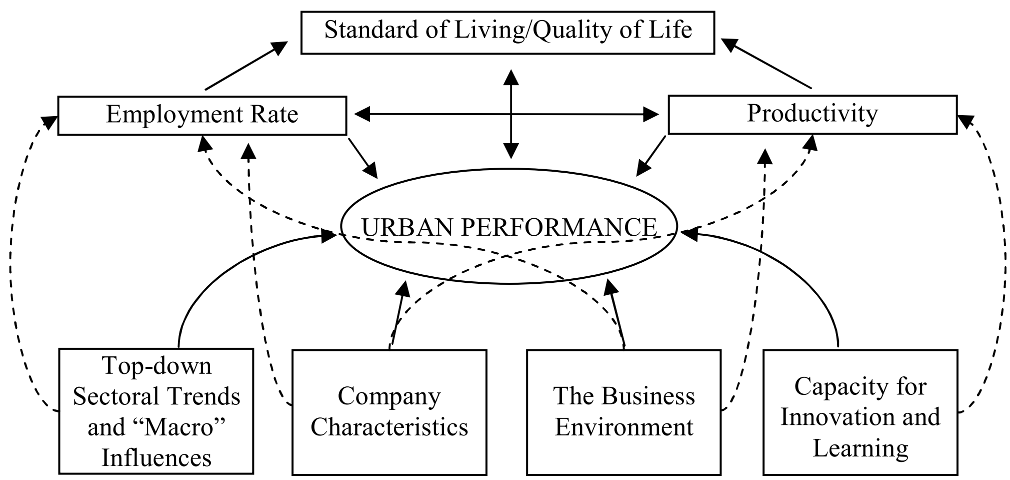


Figure A.8. Urban competitiveness maze (Begg, 1999).

The Irish National Competitiveness Council (NCC, 2007) describes sustainable growth using a simpler pyramid than the models used by Gardiner et al. (2004) or Begg (1999). The NCC competitiveness pyramid is shown in Figure A.9. Sustainable growth includes both GDP per capita and quality of life measures (e.g., life expectancy, infant mortality). Policy inputs measure the laws, services, and infrastructure provided by government (e.g., corporate tax rate, investment in telecommunications, expenditure on education, and educational attainment). Essential conditions include foreign direct investment, labor force demographics, prices and cost of living, productivity, and technology exports, among others. Policy inputs affect the essential conditions, and those two layers of the NCC pyramid work together to achieve sustainable growth.

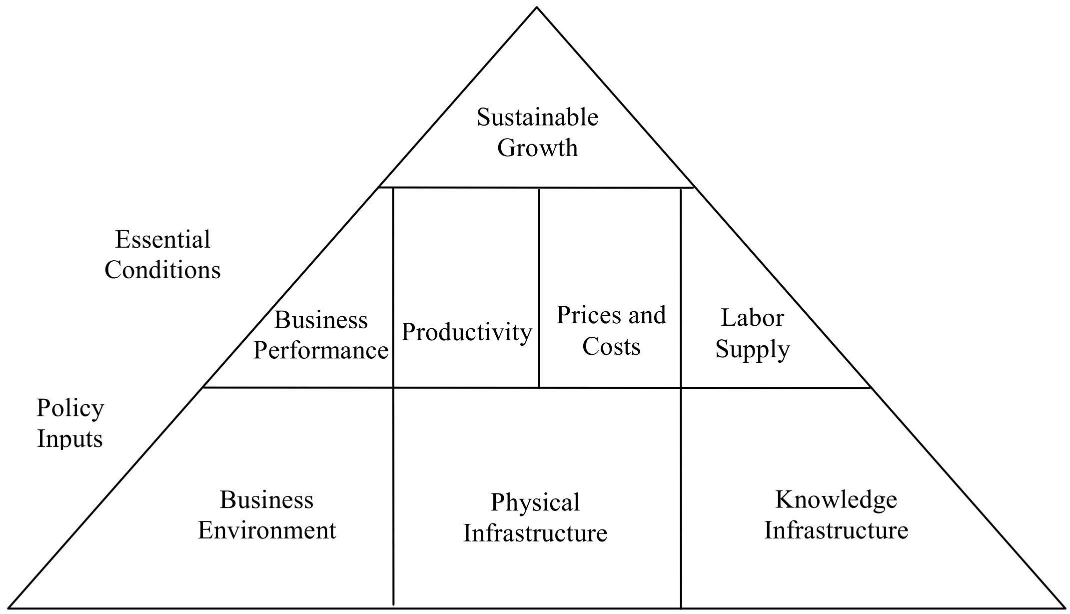


Figure A.9. NCC competitiveness pyramid (National Competitiveness Council, 2007).

## Appendix B: Summary of Data and Methodologies Used in Regional Competitiveness Ratings Reports

*2007 Development Report Card for the States (CFED, 2007)*

- Grades (A-F) are provided for three main categories: performance, business vitality, and development capacity. No overall grade is provided.
- Data are collected for 67 measures. The 67 measures are assigned to 15 sub-indices, and the sub-indices are assigned to the three main categories.
- Each state is ranked 1 (best) to 50 (worst) on every measure. Sub-indices' scores are the average rankings of the measures in the sub-indices. Main category (index) scores are the sum of sub-indices' scores within the category. No weights are used in the scoring.
- Grades are based on rank: 1-10 (A), 11-20 (B), 21-35 (C), 36-45 (D), 46-50 (F).

*2008 Best Cities to Live, Work, and Play (Stolarick, 2008)*

- Indices all include data on regional technology, talent, and tolerance as they relate to growth in population, employment, and per capita income. Cost of living and presence of a creative class figure heavily in the index.
- Variables weights are based on an undisclosed quantitative analysis.
- Variables are weighted differently for different age/lifestyle groups (e.g., singles ages 25-29 and empty-nesters ages 45-64 with no kids). Cost of living is included both as a general measure and in terms of health costs, housing costs, etc. as appropriate for different age groups. Additionally, cities of different sizes are considered more preferable for different age groups.

*Best Performing Cities, 2007 (Devol et al., 2007)*

- Indices and rankings are provided for 200 “Largest” cities and 179 “Small” cities.
- Indices are based on nine measures: rates of job growth over three time periods, rates of wage and salary growth over two periods, relative high-tech GDP growth rate over two periods, high-tech GDP location quotient, and number of high-tech industries with LQ>1.
- All measures are expressed relative to the U.S. average (U.S. average = 100).
- Overall city indices are the weighted sum of the nine adjusted measures. Weights of 0.143 are applied to job and wage growth rates, and weights of 0.071 are applied to high-tech growth rates and location quotients. City indices are used to determine rankings among large and small cities.

*Best Places to Live 2008 (Money Magazine, 2008)*

- The index ranks the 100 best cities with populations of 50,000 to 300,000. *Money Magazine* ranks cities of different sizes in different years.
- Cities are ranked overall and according to individual sub-indices for the housing, financial, and quality of live aspects of competitiveness. Housing indicators measure expensive and inexpensive homes. Financial indicators measure median incomes, mass-transit availability or short commutes, and employment growth. Quality of life indicators measure fast commutes, clean air, and population demographics.

- No information on variables weights is provided. Cities are eliminated based on their negative characteristics, and the final cities are visited to identify the "Best Places."

*Constructing and Index for Regional Competitiveness (Huovari et al., 2001)*

- The study area includes 85 Finish regions corresponding to labor market areas.
- Sixteen variables are grouped into 15 indicators (the number of students and technical student are combined into one indicator) in four sub-indices representing human capital, innovativeness, external economies, and access to other regions, and the sub-indices are found to be positively correlated (measure similar concepts).
- Variables are first adjusted to per capita form and then the regional values are set relative to the national average, which is assigned a value of 100. Finally, all variables are standardized.
- Variables are weighted equally within sub-indices, and the sub-indices also receive equal weights.
- The index provides evidence of cumulative causations and serves as a long-term indicator of competitiveness, as it is highly correlated with traditional long-term measures of well-being such as per capita GDP and personal income.

*Economic Vision 2010 Report Card, 7th Edition (Indiana Chamber of Commerce, 2007)*

- States are graded (A-F) annually according to their overall performance.
- Ninety-seven variables are included in six policy areas or drivers: education/workforce development, business costs/productivity, government/regulatory environment, infrastructure/connectivity,

dynamism/entrepreneurism, and quality of life. Each policy area is further divided into two or three sub-drivers made up of a minimum of three variables.

- Variables are normalized to the states' median and rescored to have a mean of 100.
- Variables are equally weighted within each sub-driver with the exception of the business costs/productivity sub-driver, which is weighted according to the share of business costs for a typical business. The overall score is an average of the scores for the sub-drivers.
- Letter grades are assigned based on each state's score relative to the leader for each sub-driver.
- Because current data is rarely available, the report card recalculates previous years' scores as data becomes available.

*Metro Area and State Competitiveness Report, 2005 (BHI, 2005)*

- The BHI report annually ranks the largest 50 metropolitan areas based on eight principal categories: government and fiscal policies, security, infrastructure, human resources, technology, business incubation, openness, and environmental policy. Thirty-seven indicators are assigned to the eight categories.
- Each of the 37 measures is normalized with a mean of five and a standard deviation of one. Indices for the eight principal categories are simple averages of the normalized values of the assigned indicators. Next, the eight sub-indices are normalized (mean = 5, s.d. = 1).

- The overall index is the simple average of the eight normalized sub-indices. The overall index is normalized with a mean of five and a standard deviation of 1. No weights are used on the 37 measures or eight sub-indices.

*Regional Competitiveness Indicators for Europe – Audit, Database Construction, and Analysis (Gardiner, 2003)*

- Index includes data for the members of the Eurpean Union and candidate countries from 1980 to 2001.
- Thirteen indicators are categorized as output indicators (e.g., GDP per capita) or input indicators (e.g., R&D, innovation demography).
- Three types of indicators are considered relevant to knowledge-based competitiveness: economic accounts (e.g., GDP, gross value added, and employment), education (e.g., students by education level, gender, and age), and science and technology (e.g., R&D expenditure, patents, and employment).
- The econometric model underlying the index includes spillover effects measured by Moran's *I* Statistic.

**Appendix C: Southern MSAs and Component Counties by State**

[1]County included in 2006 definition but not included in 2000 definition.

[2]County included in 2006 definition but not included in 1990 definition.

[3]Included in 2000 definition but excluded from 2006 definition.

[4]Included in 1990 definition but excluded from 2006 definition.

*Italics* indicate counties not included in 2006 definition but included in previous definitions.

<u>Alabama</u>

Anniston Oxford—Calhoun

Auburn-Opelika—Lee[2]

Birminham-Hoover—Bibb[1,2], Blount, Chilton[1,2], Jefferson, St. Clair, Shelby, Walker[1]

Decatur—Lawrence, Morgan

Dothan--Geneva[1,2], Henry[1,2], Houston, *Dale*[3,4]

Gadsden—Etowah

Huntsville—Limestone[2], Madison

Mobile—Mobile, *Baldwin*[3,4]

Montgomery—Autaga, Elmore, Lowndes[1,2], Montgomery

Tuscaloosa--Greene[1,2], Hale[1,2], Tuscaloosa

<u>Arkansas</u>

Hot Springs--Garland[1,2]

Jonesboro-Craighead[2], Poinsett[1,2]

Little Rock-North Little Rock-Conway—Faulkner, Grant[1,2], Lonoke, Perry[1,2], Pulaski, Saline

Pine Bluff--Cleveland[1,2], Jefferson, Lincoln[1,2],

Fayetteville-Springdale-Rogers, AR-MO—Benton, AR[2], Madison, AR[1,2], Washinton, AR, McDonald MO[1,2]

Fort Smith, AR-OK—Crawford, AR, Franklin, AR[1,2], Sebastian, AR, Le Flore, OK[1,2], Sequoyah, OK

Delaware

Dover—Kent[2]

Florida

Cape Coral-Fort Myers—Lee

Deltona-Daytona Beach-Ormond—Volusia, *Flagler*[3]

Fort Walton Beach-Crestview-Destin—Okaloosa

Gainesville, FL—Alachua[2], Gilchrist[1,2]

Jacksonville, FL--Baker[1,2], Clay, Duval, Nassou, St. Johns

Lakeland—Polk

Miami-Fort Lauderdale-Pompano Beach—Broward, Miami-Dade, Palm Beach[1,2]

Naples-Marco Island—Collier

Ocala—Marion

Orlando-Kissimmee—Lake[2], Orange, Osceola, Seminole

Palm Bay-Melbournce-Titus—Brevard

Palm Coast--Flagler[1,2]

Panama City-Lynn Haven—Bay

Pensacola-Ferry Pass-Brent—Escambia, Santa Rosa

Port St. Lucie—Martin, St. Lucie

Punta Gorda—Charlotte[2]

Sarasota-Bradenton-Venice—Manatee[2], Sarasota

Sebastian-Vero Beach—Indian River[1,2]

Tallahassee—Gadsden, Jefferson[1,2], Leon, Wakulla[1,2]

Tampa-St. Petersburg-Clearwater—Hernando, Hillsborough, Pasco, Pinellas

<u>Georgia</u>

Albany—Baker[s]. Dougherty, Lee, Terrell[2], Worth[2]

Athens-Clarke County—Clarke, Madison, Oconee, Oglethorpe[1,2], *Jackson*[4]

Atlanta-Sand Springs-Marietta—Barrow, Bartow[2], Butts[1], Carroll[2], Cherokee, Clayton, Cobb, Coweta, Dawson[1,2], DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Haralson[1,2], Heard[1,2], Henry, Jasper[1,2], Lamar[1,2], Meriwether[1,2], Newton, Paulding, Pickens[2], Pike[1,2], Rockdale, Spalding, Walton

Brunswick--Brantley[1,2], Glynn[1,2], McIntosh[1,2]

Dalton--Murray[1,2], Whitfield[1,2]

Gainesville, GA--Hall[1,2]

Hinesville-Fort Stewart--Liberty[1,2], Long[1,2],

Macon—Bibb, Crawford[1,2], Jones, Monroe[1,2], Twiggs[2], *Houston*[3,4], *Peach*[3,4] *(Split from Warner Robins)*

Rome--Floyd[1,2]

Savannah—Bryan[2], Chatham, Effingham

Valdosta--Brooks[1,2], Echols[1,2], Lanier[1,2], Lowndes[1,2]

Warner Robins--Houston[1,2] *(Split from Macon)*

Augusta-Richmond County, GA-SC—Burke, GA[1,2], Columbia, GA, McDuffie, GA, Richmond, GA, Aiken, SC, Edgefield, SC

Columbus, GA-AL—Russell, AL, Chattahoochee, AL, Harris, GA[2], Marion, GA[1,2], Muscogee, GA

<u>Kentucky</u>

Bowling Green--Edmonson[1,2], Warren[1,2]

Elizabethtown--Hardin[1,2], Larue[1,2]

Lexington-Fayette—Bourbon, Clark, Fayette, Jessamine, Scott, Woodford, *Madison*[3]

Owensboro—Daviess, Hancock[1,2], McLean[1,2]

Evansville, IN-KY—Gibson, IN[1,2], Posey, IN, Vanderburgh, IN, Warrick, IN, Henderson, KY, Webster, KY[1,2]

Louisville-Jefferson County, KY-IN—Clark, IN, Floyd, IN, Harrison, IN, Washington, IN[1,2], *Scott, IN*[3], Bullitt, KY, Henry, KY[1,2], Jefferson, KY, Meade, KY[1,2], Nelson, KY[1,2], Oldham, KY, Shelby, KY[1], Spencer, KY[1,2], Trimble, KY[1,2]

Cincinnati-Middletown, OH-KY-IN—Dearborn, IN, Franklin, IN[1,2], Ohio, IN, Boone, KY, Bracken, KY[1,2], Campbell, KY, Gallatin, KY[2], Grant, KY[2], Kenton, KY, Pendleton, KY[2], Brown, OH[2], Butler, OH, Clermont, OH, Hamilton, OH, Warren, OH

Louisiana

Alexandria—Grant[2], Rapides

Baton Rouge—Ascension, East Baton Rouge, East Feliciana[1,2], Iberville[1,2], Livingston, Pointe Coupee[1,2], St. Helena[1,2], West Baton Rouge, West Feliciana[1,2]

Houma-Bayou Cane-Thibodaux—Lafourche, Terrebonne

Lafayette—Lafayette, St. Martin, *Acadia*[3], *St. Landry*[3]

Lake Charles—Calcasieu, Cameron[1,2]

Monroe—Ouachita, Union[1,2]

New Orleans-Metairie-Kenner—Jefferson, Orleans, Plaquemines[2], St. Bernard, St. Charles, St. John the Baptist, St. Tammany, *St. James*[3]

Shreveport-Bossier City—Bossier, Caddo, De Soto[2], *Webster*[3]

Maryland

Baltimore-Towson (Metropolitan Division)—Anne Arundel, Baltimore, Baltimore city Carroll, Harford, Howard, Queen Anne's

Salisbury--Somerset[1,2], Wicomico[1,2],

Cumberland, MD-WV—Allegany, MD, Mineral, WV

Hagerstown-Martinsburg, MD-WV—Washington, MD, Berkeley, WV[1,2], Morgan, WV[1,2]

Mississippi

Gulfport-Biloxi—Hancock, Harrison, Stone[1,2], *Jackson*[3]

Hattiesburg—Forrest[2], Lamar[2], Perry[1,2]

Jackson, MS--Copiah[1,2], Hinds, Madison, Rankin, Simpson[1,2]

Pascagoula--George[1,2], Jackson[1] *(Split from Gulfport-Biloxi)*

North Carolina

Asheville—Buncombe, Haywood[1,2], Henderson[1,2], Madison[2]

Burlington—Alamance[1]

Durham--Chatham[1,2], Durham[1,2], Orange[1,2], Person[1,2] *(Split from Raleigh-Cary)*

Fayetteville—Cumberland, Hoke[1,2]

Goldsboro—Wayne[2]

Greensboro-High Point--Guilford[1,2], Randolph[1,2], Rockingham[1,2] *(Split from Winston-Salem)*

Greenville, NC--Greene[1,2], Pitt[2]

Hickory-Lenoir-Morganton—Alexander, Burke, Caldwell[2], Catawba

Jacksonville, NC—Onslow

Raleigh-Cary--Franklin[1,2], Johnston[1,2], Wake[1,2] *(Split from Durham)*

Rocky Mount—Edgecombe[2], Nash[2]

Wilmington, NC—Brunswick[2], New Hanover, Pender[1,2]

Winston-Salem—Davie[1,2], Forsyth[1,2], Stokes[1,2], Yadkin[1,2] *(Split from Greensboro-High Point)*

Charlotte-Gastonia-Concord, NC-SC—Anson, NC[1,2], Cabarrus, NC, Mecklenburg, NC, Union, NC, *Rowan, NC*[3,4], *Lincoln, NC*[3,4], York, SC

<u>Oklahoma</u>

Lawton—Comanche

Oklahoma City—Canadian, Cleveland, Grady[1,2], Lincoln[1,2], Logan, McClain, Oklahoma, *Pottawatomie*[3,4]

Tulsa—Creek, Okmulgee[1,2], Osage, Pawnee[1,2], Rogers, Tulsa, Wagoner

<u>South Carolina</u>

Anderson—Anderson[1,2] *(Split from Greenville and Spartanburg)*

Charleston-North Charleston, SC—Berkeley, Charleston, Dorchester

Columbia--Calhoun[1,2], Fairfield[1,2], Kershaw[1,2], Lexington, Richland, Saluda[1,2]

Florence--Darlington[1,2], Florence

Greenville-Mauldin-Easley--Greenville[1,2], Laurens[1,2], Pickens[1,2] *(Split from Anderson and Spartanburg)*

Myrtle Beach-Conway-North Myrtle Beach—Horry

Spartanburg--Spartanburg[1,2] *(Split from Anderson and Greenville)*

## Tennessee

Cleveland--Bradley[1,2], Polk[1,2]

Jackson, TN—Chester[2], Madison

Johnson City—Carter, Unicoi, Washington *(Split from Kingsport-Bristol)*

Knoxville—Anderson, Blount, Knox, Loudon[2], Union, *Grainger*[4], *Jefferson*[4], *Sevier*[3,4]

Morristown--Grainger[1,2], Hamblen[1,2], Jefferson[1,2]

Nashville-Davidson-Murfreesboro-Franklin—Cannon[1,2], Cheatham, Davidson, Dickson, Hickman[1,2], Macon[1,2], Robertson, Rutherford, Smith[1,2], Sumner, Trousdale[1,2], Williamson, Wilson

Memphis, TN-AR-MS—Crittenden, AR, DeSoto, MS, Marshall, MS[1,2], Tate, MS[1,2], Tunica, MS[1,2], Fayette, TN[2], Shelby, TN, Tipton, TN

Chattanooga, TN-GA—Catoosa, GA, Dade, GA, Walker, GA, Hamilton, TN, Marion, TN, Sequatchie, TN[1]

Clarksville, TN-KY—Christian, KY, Trigg, KY[1,2], Montgomery, TN, Stewart, TN[1,2]

Kingsport-Bristol, TN-VA—Hawkins, TN[1,2], Sullivan, TN[1,2], Bristol city, VA[1,2], Scott, VA[1,2], Washington, VA[1,2] *(Split from Johnson City)*

## Texas

Abilene—Callahan[1,2], Jones[1,2], Taylor

Amarillo—Armstrong[1,2], Carson[1,2], Potter, Randall

Austin-Round Rock—Bastrop[2], Caldwell[2], Hays, Travis, Williamson

Beaumont-Port Arthur—Hardin, Jefferson, Orange

Brownsville-Harlingen—Cameron

College Station-Bryan—Brazos, Burleson[1,2], Robertson[1,2]

Corpus Christi—Aransas[1,2], Nueces, San Patricio

Dallas-Fort Worth-Arlington—Collin, Dallas, Delta[1,2], Denton, Ellis, Hunt[2], Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise[1,2], *Henderson*[3], *Hood*[3]

El Paso—El Paso

Houston-Sugar Land-Baytown—Austin[1,2], Brazoria, Chambers[2], Fort Bend, Galveston[1], Harris, Liberty, Montgomery, San Jacinto[1,2], Waller

Killeen-Temple-Fort Hood—Bell, Coryell, Lampasas[1,2]

Laredo—Webb

Longview—Gregg, Rusk[1,2], Upshur[2], *Harrison*[3,4]

Lubbock—Crosby[1,2], Lubbock

McAllen-Edinburg-Mission—Hildago

Midland—Midland[1] *(Split from Odessa)*

Odessa—Ector[1] *(Split from Midland)*

San Angelo—Irion[1,2], Tom Green

San Antonio—Atascosa[1,2], Bandera[1,2], Bexar, Comal, Guadalupe, Kendall[1,2], Medina[1,2], Wilson[2]

Sherman-Denison—Grayson

Tyler—Smith

Victoria—Calhoun[1,2], Goliad[1,2], Victoria

Waco—McLennan

Wichita Falls—Archer[2], Clay[1,2], Wichita

Texarkana, TX-AR—Miller, AR, Bowie, TX

Virginia

Blacksburg-Christiansburg-Radford—Giles[1,2], Montgomery[1,2], Pulaski[1,2], Radford[1,2]

Charlottesville—Albemarle, Charlottesville city, Fluvanna, Greene, Nelson[1,2]

Danville—Danville city, Pittsylvania

Harrisonburg—Harrisonburg city[1,2], Rockinham[1,2]

Lynchburg—Amherst, Appomattox[1,2], Bedford[2], Bedford city[2], Campbell, Lynchburg city

Richmond—Amelia[1,2], Caroline[1,2], Charles City (county), Chesterfield, Colonial Heights city, Cumberland[1,2], Dinwiddie, Goochland, Hanover, Henrico, Hopewell city, King and Queen[1,2], King William[1,2], Louisa[1,2], New Kent, Petersburg city, Powhatan, Prince George, Richmond city, Sussex[1,2]

Roanoke—Botetourt, Craig[1,2], Franklin[1,2], Roanoke, Roanoke city, Salem city

Virginia Beach-Norfolk-Newport News, VA-NC—Currituck, NC[2], Chesapeake city, VA, Gloucester, VA, Hampton city, VA, Isle of Wight, VA[2], James City (county), VA, Mathews, VA[2], Newport News city, VA, Poquoson city, VA, Portsmouth city, VA, Suffolk city, VA, Surry, VA[1,2], Virginia Beach city, VA, Williamsburg city, VA, York, VA

Winchester, VA-WV—Frederick, VA[1,2], Winchester city, VA[1,2], Hampshire, WV[1,2]

West Virginia

Charleston—Boone[1,2], Clay[1,2], Kanawha, Lincon[1,2], Putnam

Morgantown—Monongalia[1,2], Preston[1,2]

Huntington-Ashland, WV-KY-OH—Boyd, KY, Greenup, KY, *Carter, KY*[3,4], Lawrence, OH, Cabell, WV, Wayne, WV

Parkersburg-Marietta-Vienna, WV-OH—Washington, OH, Pleasants, WV[1,2], Wirt, WV[1,2],Wood, WV

Weirton-Steubenville, WV-OH—Jefferson, OH, Brooke, WV, Hancock, WV

Wheeling, WV-OH—Belmont, OH, Marshall, WV, Ohio, WV

# Appendix D: Factor Scores

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abilene, TX | -0.0089 | 0.0285 | 0.2046 | 158822 | 69690 | 20320 | -0.0986 | 1.3930 | -0.1321 | 3.3673 | -0.4366 | 1.3883 | -0.1418 | -0.1156 |
| Albany, GA | 0.3004 | 0.3121 | 0.0942 | 163150 | 67466 | 19022 | -0.3549 | -1.1837 | -1.2114 | -2.6580 | -0.4369 | -0.1837 | 0.1018 | 0.1023 |
| Alexandria, LA | 0.1697 | 0.2573 | 0.1682 | 149707 | 65419 | 19034 | -0.3102 | 0.3454 | -1.1353 | 0.7908 | -0.7952 | 0.2256 | 0.5139 | -1.2251 |
| Amarillo, TX | 0.0594 | 0.0995 | 0.1365 | 240382 | 116431 | 20940 | -0.2283 | 1.2800 | 0.1487 | 3.5967 | -0.3552 | 0.5831 | -1.0849 | -0.6895 |
| Anderson, SC | 0.0662 | 0.0467 | 0.0759 | 177086 | 81451 | 19814 | -0.5117 | -3.0301 | 0.5086 | -0.4110 | -0.6944 | 0.1660 | 1.2629 | 0.1255 |
| Anniston-Oxford, AL | 0.0040 | -0.0022 | 0.1514 | 112704 | 47751 | 20205 | -0.3232 | -2.4895 | -0.2795 | 3.0261 | -0.3992 | -0.2306 | 0.4138 | -0.9506 |
| Asheville, NC | 0.0747 | 0.1021 | 0.1642 | 397801 | 191921 | 23642 | -0.3241 | -0.4041 | 0.7489 | 1.1852 | 0.1121 | 0.3345 | -0.4889 | -0.1462 |
| Athens-Clarke County, GA | 0.0989 | 0.1217 | 0.1168 | 183346 | 91164 | 20467 | 3.1490 | 1.6083 | -0.2766 | -0.8484 | -0.0717 | 0.1090 | 0.2127 | 0.1042 |
| Atlanta-Sandy Springs-Marietta, GA | 0.1882 | 0.1695 | 0.1004 | 5127841 | 2550803 | 27403 | 0.1058 | 2.8294 | 1.3521 | -0.2786 | 1.5097 | -1.2388 | -0.8254 | 1.7740 |
| Auburn-Opelika, AL | 0.1066 | 0.1292 | 0.2380 | 128033 | 60284 | 21768 | 3.2142 | 0.4278 | -0.8106 | -1.2382 | 0.3655 | -1.1415 | 0.9172 | -1.3157 |
| Augusta-Richmond County, GA-SC | 0.0449 | 0.0428 | 0.1517 | 522608 | 221800 | 21524 | -0.1649 | -0.1666 | 0.2791 | -2.0745 | -0.1714 | -0.6661 | 0.3820 | 1.9396 |
| Austin-Round Rock, TX | 0.2038 | 0.1681 | 0.1299 | 1532281 | 781743 | 27918 | 1.2962 | 5.1341 | 0.6707 | 1.2661 | 1.3922 | -0.0267 | -0.3588 | 1.2954 |
| Baltimore-Towson, MD | 0.0423 | 0.0823 | 0.2246 | 2663286 | 1338696 | 30541 | 0.5530 | 2.7899 | 1.1854 | -0.8942 | 0.0068 | -0.9935 | -0.6383 | 1.4083 |
| Baton Rouge, LA | 0.0796 | 0.1098 | 0.1799 | 764488 | 350677 | 21825 | 0.5359 | 1.8721 | -0.5749 | -0.8304 | -0.3444 | -0.7797 | -0.3017 | 1.8413 |
| Beaumont-Port Arthur, TX | -0.0281 | 0.0221 | 0.1959 | 374435 | 159456 | 21428 | -0.2780 | -0.1214 | -0.4547 | -0.5595 | -0.5617 | -0.5465 | 0.0945 | 1.5866 |
| Birmingham-Hoover, AL | 0.0445 | 0.0552 | 0.1803 | 1100071 | 502957 | 24719 | -0.0646 | 0.9237 | 0.1791 | -0.6027 | -0.0646 | -1.1542 | -1.2092 | 1.1595 |
| Blacksburg-Christiansburg-Radford, VA | 0.0320 | -0.0051 | 0.1226 | 156195 | 69971 | 19635 | 3.6564 | -0.3747 | -0.5300 | -0.9400 | -0.5236 | -0.3092 | 1.3356 | 0.2318 |
| Bowling Green, KY | 0.0913 | 0.0876 | 0.2098 | 114122 | 56143 | 22644 | 0.1003 | -1.1496 | -0.2600 | 0.3797 | -0.4828 | -0.2386 | -0.1555 | -1.4766 |
| Brownsville-Harlingen, TX | 0.1246 | 0.2120 | 0.0871 | 379708 | 134621 | 11958 | -0.4768 | -2.0129 | -5.2056 | -0.2907 | 0.0805 | 0.9014 | -0.1067 | -1.2681 |
| Brunswick, GA | 0.0717 | 0.0744 | 0.2354 | 99963 | 45714 | 24779 | -0.4619 | -0.3903 | 0.3586 | -0.3868 | 0.8520 | 1.0020 | 0.3499 | 0.6677 |
| Burlington, NC | 0.0819 | 0.0640 | 0.0474 | 141965 | 69186 | 20333 | -0.5145 | -2.9067 | 1.2829 | 0.2718 | -0.8974 | -0.7771 | 0.9776 | 0.6157 |
| Cape Coral-Fort Myers, FL | 0.2570 | 0.3394 | 0.1693 | 570089 | 261749 | 29069 | -0.4853 | 1.4743 | 0.5921 | 1.8571 | 2.2684 | 1.5896 | 0.7615 | 0.6290 |
| Charleston, WV | -0.0189 | -0.0188 | 0.0913 | 303848 | 129628 | 20913 | -0.2683 | 0.5415 | -0.5072 | 0.4759 | -0.9700 | -0.0632 | -0.3375 | 1.8607 |
| Charleston-North Charleston, SC | 0.1170 | 0.1356 | 0.2544 | 617172 | 283890 | 25499 | -0.0736 | 0.9959 | 0.6824 | -1.2448 | 1.0201 | -0.2296 | -0.8631 | -0.0063 |
| Charlotte-Gastonia-Concord, NC | 0.1750 | 0.1686 | 0.1215 | 1584844 | 806585 | 27094 | -0.2795 | 0.5863 | 1.3520 | -0.4499 | 0.6506 | -1.5067 | -0.1536 | 0.9815 |

Continued.

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions, Continued.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charlottesville, VA | 0.0910 | 0.0756 | 0.2160 | 190602 | 91886 | 29073 | 2.6348 | 3.4993 | 1.0084 | 0.8965 | -0.0892 | 0.4918 | 0.2082 | 0.8495 |
| Chattanooga, TN-GA | 0.0672 | 0.0467 | 0.1418 | 509639 | 239029 | 22886 | -0.3690 | -1.0025 | 0.3516 | 0.0311 | -0.2428 | -0.9480 | -0.6117 | 0.6174 |
| Cincinnati-Middletown, OH-KY-IN | 0.0540 | 0.0424 | 0.1305 | 2121128 | 1025327 | 26060 | 0.0515 | 0.9576 | 0.7022 | -0.2867 | -0.7215 | -1.5966 | -1.5051 | 1.2454 |
| Clarksville, TN-KY | 0.0850 | 0.0544 | 0.2199 | 252580 | 94293 | 20412 | -0.3784 | -1.3233 | 0.2691 | -0.9287 | 0.1819 | 1.1626 | -0.7833 | -1.5085 |
| Cleveland, TN | 0.0513 | -0.0237 | 0.1259 | 109485 | 48250 | 20173 | -0.5836 | -4.0158 | 0.3123 | 2.1498 | -0.2313 | -1.1739 | 1.8036 | -2.2422 |
| College Station-Bryan, TX | 0.0829 | 0.0319 | 0.1448 | 200860 | 88209 | 18629 | 5.8525 | 3.4727 | -1.0929 | 0.0491 | -0.0048 | 0.8608 | 1.8945 | -0.5577 |
| Columbia, SC | 0.0839 | 0.0954 | 0.1445 | 703783 | 341969 | 23412 | 0.3217 | 1.9925 | 1.0272 | -1.4831 | 0.2239 | -0.6169 | -0.9530 | 0.0693 |
| Columbus, GA-AL | 0.0300 | 0.0291 | 0.2258 | 290347 | 116017 | 21895 | -0.3699 | -1.2395 | -0.2500 | -2.6938 | -0.1853 | -0.3477 | -0.3856 | 0.5801 |
| Corpus Christi, TX | 0.0247 | 0.0591 | 0.1457 | 413365 | 174515 | 19497 | -0.2618 | 0.2916 | -1.2603 | 0.8692 | -0.3224 | 0.7422 | -0.2117 | 0.1879 |
| Cumberland, MD-WV | -0.0267 | 0.0065 | 0.1273 | 99318 | 42093 | 18636 | -0.1962 | -1.3740 | -0.5104 | 0.2622 | -1.8765 | 0.9707 | 0.4139 | -0.9403 |
| Dallas-Fort Worth-Arlington, TX | 0.1477 | 0.1548 | 0.1016 | 5982787 | 2977990 | 26174 | 0.0893 | 2.9400 | 0.9410 | 1.9069 | 1.1351 | -1.0544 | -0.9019 | 1.8017 |
| Dalton, GA | 0.0990 | 0.0837 | -0.0185 | 132527 | 62403 | 17493 | -0.7995 | -6.0939 | 0.6445 | -0.9716 | -0.4514 | -2.0313 | 4.8946 | 1.3570 |
| Danville, VA | -0.0360 | -0.0441 | 0.1094 | 106256 | 47134 | 19034 | -0.6817 | -5.2051 | -0.1917 | -1.2453 | -1.5903 | -0.1893 | 1.6225 | -0.1351 |
| Decatur, AL | 0.0148 | 0.0232 | 0.1175 | 148035 | 66925 | 20893 | -0.5112 | -2.5622 | 0.2949 | 0.1990 | -0.0263 | -0.0667 | 0.8203 | -0.4888 |
| Deltona-Daytona Beach-Ormond Beach, FL | 0.1119 | 0.1705 | 0.2019 | 495813 | 224180 | 24064 | -0.3410 | 0.7453 | 0.0906 | -0.5976 | 1.4159 | 1.2468 | -0.3618 | -0.7220 |
| Dothan, AL | 0.0499 | 0.0534 | 0.1318 | 137562 | 61121 | 20035 | -0.5615 | -2.4246 | -0.0152 | -0.8011 | -0.2569 | -0.3238 | -0.2511 | -0.7007 |
| Dover, DE | 0.1552 | 0.1346 | 0.2265 | 147973 | 66236 | 23407 | -0.2583 | -0.7295 | 0.8796 | -0.2597 | -0.0262 | -0.0214 | 0.4288 | -0.6550 |
| Durham, NC | 0.0954 | 0.0812 | 0.1409 | 469196 | 237252 | 26806 | 2.6597 | 4.0774 | 1.2726 | -0.9744 | 0.2281 | -0.8886 | 0.4431 | 3.9718 |
| Elizabethtown, KY | 0.0290 | 0.0395 | 0.2091 | 110713 | 47641 | 21305 | -0.3497 | -1.2042 | 0.0638 | -1.0070 | -0.2851 | 0.0583 | -0.3129 | -0.2359 |
| El Paso, TX | 0.0654 | 0.1474 | 0.0946 | 725559 | 278954 | 14752 | -0.1930 | -0.5795 | -2.8065 | -0.7619 | 0.6505 | -0.0984 | -0.5337 | -1.8824 |
| Evansville, IN-KY | 0.0169 | 0.0234 | 0.1457 | 348641 | 172272 | 23169 | -0.3382 | -1.0993 | 0.5653 | 0.4829 | -1.3591 | -0.7141 | -0.5406 | 0.5898 |
| Fayetteville, NC | 0.0352 | 0.0367 | 0.1540 | 348660 | 128069 | 19833 | -0.3092 | -0.0675 | 0.4804 | -2.6437 | -0.2464 | -0.0747 | 0.0002 | -0.5009 |
| Fayetteville-Springdale-Rogers, AR-OK | 0.1992 | 0.2154 | 0.1940 | 423556 | 205079 | 21704 | 0.0264 | -1.6119 | 0.5287 | 1.3640 | 0.8936 | -0.4912 | 0.4170 | -0.4975 |
| Florence, SC | 0.0234 | 0.0223 | 0.1020 | 197737 | 86298 | 19180 | -0.5042 | -2.4601 | -0.2706 | -2.3464 | -0.7105 | -0.5516 | -0.6384 | -0.8936 |
| Florence-Muscle Shoals, AL | -0.0029 | 0.0308 | 0.1277 | 142539 | 63958 | 20685 | -0.4152 | -2.4484 | -0.0223 | 0.1485 | -0.6268 | 0.4085 | -0.0552 | -0.7229 |

Continued.

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions, Continued.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fort Smith, AR-OK | 0.0480 | 0.0722 | 0.1317 | 286598 | 127866 | 18218 | -0.6058 | -2.8797 | -0.3602 | 1.3849 | 0.0488 | -0.2510 | -0.4622 | -0.4101 |
| Fort Walton Beach-Crestview-Destin, FL | 0.0707 | 0.0772 | 0.3453 | 182994 | 77770 | 29546 | 0.0245 | 3.0907 | 1.3667 | -0.7118 | 1.0686 | 1.2530 | 1.0164 | 0.6126 |
| Gadsden, AL | -0.0053 | -0.0208 | 0.0430 | 102911 | 42534 | 17521 | -0.6143 | -3.5488 | -0.5247 | -0.3064 | -1.1825 | -0.6161 | -0.1989 | -2.5518 |
| Gainesville, FL | 0.0873 | 0.0665 | 0.2249 | 253587 | 118680 | 22773 | 3.8258 | 5.2822 | -0.0715 | -0.4768 | 0.2743 | 0.6615 | 1.8666 | -0.5106 |
| Gainesville, GA | 0.2133 | 0.1763 | 0.0168 | 172391 | 79421 | 20024 | -0.4675 | -2.4403 | 0.7447 | 0.5291 | 0.3545 | -0.8315 | 0.1148 | 0.2763 |
| Goldsboro, NC | -0.0045 | 0.0213 | 0.0926 | 112819 | 48153 | 18661 | -0.4284 | -1.5279 | 0.7121 | -2.2075 | -1.2705 | -0.5554 | -0.3011 | -0.8603 |
| Greensboro-High Point, NC | 0.0652 | 0.0119 | 0.0686 | 686757 | 330575 | 22938 | -0.2522 | -1.1607 | 1.2442 | -0.3887 | -0.4012 | -1.6539 | -0.0447 | 1.0604 |
| Greenville, NC | 0.1002 | 0.0685 | 0.1428 | 168867 | 77593 | 20644 | 0.4592 | -0.3143 | -0.1147 | -1.4912 | 0.1433 | -0.6626 | 0.6861 | -0.8298 |
| Greenville-Mauldin-Easley, SC | 0.0700 | 0.0335 | 0.0952 | 600513 | 282284 | 22412 | 0.2207 | -0.5393 | 0.7463 | -0.6004 | -0.0893 | -1.7225 | 0.1152 | 1.0196 |
| Gulfport-Biloxi, MS | -0.0789 | -0.1097 | 0.1374 | 227515 | 94336 | 20413 | -0.2217 | 0.6862 | -0.4511 | -0.9471 | -0.0054 | 0.6959 | -0.8324 | -0.3557 |
| Hagerstown-Martinsburg, MD-WV | 0.1404 | 0.1982 | 0.2697 | 256359 | 127201 | 25174 | -0.5454 | -2.0617 | 0.7156 | 0.3604 | -0.7858 | -0.0732 | -0.9990 | -0.2803 |
| Harrisonburg, VA | 0.0701 | 0.0202 | 0.1673 | 116050 | 54577 | 20495 | 0.1838 | -1.8786 | 0.6715 | 1.0902 | -0.9869 | -0.1270 | 1.0245 | -0.8114 |
| Hattiesburg, MS | 0.0891 | 0.0629 | 0.1577 | 135352 | 58287 | 18846 | 0.5424 | 0.0865 | -1.0785 | -0.2847 | 0.3752 | 0.6584 | -0.0742 | -0.7304 |
| Hickory-Morganton-Lenoir, NC | 0.0434 | -0.0674 | 0.0592 | 357029 | 164912 | 19864 | -0.7251 | -5.2664 | 1.2081 | 0.1814 | -1.3526 | -2.2057 | 3.2322 | 1.5451 |
| Hinesville-Fort Stewart, GA | -0.0034 | 0.2324 | 0.1675 | 71667 | 26745 | 16166 | -0.5253 | -0.7047 | -0.0008 | -4.1304 | 1.6328 | 1.6481 | 1.5974 | -0.7170 |
| Hot Springs, AR | 0.0784 | 0.0994 | 0.1418 | 95253 | 40349 | 21469 | -0.4708 | 0.0833 | -0.3212 | 2.0753 | 0.1845 | 1.3787 | 0.4950 | -1.5699 |
| Houma-Bayou Cane-Thibodaux, LA | 0.0332 | 0.1288 | 0.2106 | 201035 | 89416 | 19676 | -0.5544 | -2.5923 | -1.5844 | 0.2479 | -0.9949 | 0.8042 | 0.6209 | -0.5183 |
| Houston-Sugar Land-Baytown, TX | 0.1036 | 0.1508 | 0.1404 | 5507557 | 2621988 | 24917 | 0.1708 | 2.8088 | 0.2049 | 1.4407 | 0.7591 | -1.1524 | -0.9151 | 2.1404 |
| Huntington-Ashland, WV-KY-OH | -0.0150 | 0.0366 | 0.2001 | 284363 | 119374 | 20312 | -0.2152 | -1.0837 | -0.9374 | -0.0350 | -1.2520 | -0.1625 | -0.7212 | -0.4164 |
| Huntsville, AL | 0.0991 | 0.0894 | 0.1697 | 378054 | 180025 | 26156 | 0.6872 | 4.0592 | 1.1413 | -1.1853 | 0.4357 | -1.0760 | 0.7904 | 1.2421 |
| Jackson, MS | 0.0662 | 0.1049 | 0.1606 | 531222 | 248085 | 21945 | 0.0646 | 2.1249 | -0.2616 | -1.1726 | -0.2038 | -0.5349 | -1.1427 | 0.5516 |
| Jackson, TN | 0.0441 | -0.0076 | 0.0708 | 112217 | 50269 | 20246 | -0.2447 | -0.9211 | -0.2232 | -0.5523 | -0.1379 | -1.0579 | -0.8273 | -0.6099 |
| Jacksonville, FL | 0.1300 | 0.1474 | 0.1777 | 1278626 | 613233 | 25838 | -0.3140 | 1.5435 | 0.9656 | -0.4173 | 1.1956 | -0.3321 | -0.1756 | 0.8169 |
| Jacksonville, NC | 0.0744 | 0.0096 | 0.2215 | 161974 | 49495 | 18536 | -0.4635 | 0.5822 | 1.1221 | -2.3468 | 0.7328 | 1.7562 | 1.1268 | -1.7764 |
| Johnson City, TN | 0.0526 | -0.0112 | 0.1000 | 191416 | 83579 | 19197 | -0.2273 | -1.8407 | -0.1552 | 0.8037 | -0.5560 | -0.1390 | -0.1907 | -0.8141 |

Continued.

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions, Continued.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jonesboro, AR | 0.0620 | 0.0027 | 0.1541 | 114655 | 50883 | 18829 | -0.2850 | -2.3327 | -0.4887 | 1.7126 | -0.1100 | 0.1418 | -0.5295 | -0.1592 |
| Killeen-Temple-Fort Hood, TX | 0.0781 | 0.1344 | 0.1833 | 357580 | 136102 | 19916 | -0.2339 | 0.5968 | 0.1541 | -1.7253 | -0.0719 | 0.4490 | 0.3269 | -0.9381 |
| Kingsport-Bristol, TN-VA | 0.0107 | 0.0019 | 0.1172 | 301709 | 131304 | 20307 | -0.4933 | -2.7520 | -0.0387 | 0.0609 | -0.6762 | -0.5074 | 0.1344 | -0.8437 |
| Knoxville, TN | 0.0843 | 0.0805 | 0.1499 | 670282 | 319342 | 24192 | 0.5098 | 1.8114 | 0.5062 | 1.4201 | -0.1533 | -0.6065 | -1.2317 | -0.3216 |
| Lafayette, LA | 0.0632 | 0.1241 | 0.2846 | 254678 | 121942 | 24196 | 0.0167 | 1.8811 | -0.8229 | 0.2477 | -0.3823 | -0.3811 | 0.2015 | -0.0212 |
| Lake Charles, LA | -0.0127 | -0.0040 | 0.2112 | 191131 | 83262 | 21724 | -0.3231 | -0.5523 | -0.7202 | -0.3841 | -0.9196 | -0.0774 | 0.0958 | -0.1486 |
| Lakeland, FL | 0.1425 | 0.1696 | 0.1167 | 558023 | 244623 | 20567 | -0.5683 | -1.0644 | -0.2868 | 0.2294 | 0.2731 | -0.4102 | -0.4786 | 0.4429 |
| Laredo, TX | 0.1640 | 0.3069 | 0.1049 | 227544 | 85025 | 11949 | -0.5364 | -2.4262 | -5.1012 | -0.2623 | 1.5718 | 0.9560 | 1.7003 | -1.2130 |
| Lawton, OK | -0.0229 | 0.0042 | 0.2010 | 112388 | 40606 | 19230 | -0.1364 | 2.1679 | 0.0358 | -1.2262 | -0.5269 | 1.2203 | 0.5567 | -2.0004 |
| Lexington-Fayette, KY | 0.0766 | 0.0580 | 0.1451 | 440815 | 225411 | 25445 | 0.9274 | 2.4352 | 0.9340 | 0.8013 | -0.2683 | -0.9267 | -1.0850 | 0.1430 |
| Little Rock-North Little Rock-Conway, AR | 0.0740 | 0.0804 | 0.1821 | 657392 | 316394 | 24142 | -0.0349 | 1.5465 | 0.6776 | -0.3848 | 0.1303 | -0.5543 | -1.4252 | 0.8086 |
| Longview, TX | 0.0389 | 0.1256 | 0.1780 | 201731 | 93677 | 21071 | -0.4204 | -1.0268 | -0.4183 | 2.6617 | -0.0985 | 0.6557 | -0.9229 | -0.1473 |
| Louisville-Jefferson County, KY-IN | 0.0491 | 0.0324 | 0.1106 | 1220424 | 585015 | 23848 | -0.1782 | -0.1673 | 0.5647 | -0.2207 | -0.4695 | -1.3917 | -1.8138 | 0.9513 |
| Lubbock, TX | 0.0597 | 0.0465 | 0.1741 | 265062 | 122942 | 20521 | 0.9411 | 2.4965 | -0.3475 | 2.7597 | -0.2589 | 0.1684 | 0.0985 | 0.3307 |
| Lynchburg, VA | 0.0508 | 0.1159 | 0.1879 | 240519 | 121479 | 22733 | -0.2756 | -1.4882 | 0.5604 | -0.5665 | -1.0202 | -0.4297 | -0.7053 | -0.6188 |
| Macon, GA | 0.0295 | -0.0376 | 0.0376 | 229026 | 91750 | 19420 | -0.2765 | -0.7714 | -0.2441 | -1.8218 | -0.4481 | -0.7053 | -0.7731 | -1.0064 |
| McAllen-Edinburg-Mission, TX | 0.1913 | 0.3472 | 0.1857 | 689494 | 254889 | 11919 | -0.5298 | -2.1478 | -5.8532 | 0.4303 | 1.3662 | 0.7650 | 0.6472 | -2.2421 |
| Memphis, TN-AR-MS | 0.0537 | 0.0533 | 0.1173 | 1271720 | 576627 | 22481 | -0.1436 | 0.5457 | -0.1712 | -1.3726 | -0.0813 | -1.7862 | -0.8390 | 0.8174 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 0.0783 | 0.1700 | 0.1381 | 5415440 | 2566115 | 25647 | -0.0724 | 1.5640 | -0.3858 | -0.4032 | 1.8388 | 1.0416 | -0.4207 | 0.9228 |
| Midland, TX | 0.0631 | 0.1810 | 0.2870 | 123561 | 61873 | 27140 | -0.1311 | 4.1675 | 0.1530 | 7.4693 | 0.2430 | 1.5341 | 1.5060 | 0.9804 |
| Mobile, AL | 0.0056 | 0.0448 | 0.1519 | 402098 | 172204 | 19996 | -0.1924 | 0.5919 | -0.8576 | -1.2776 | -0.3392 | -0.5533 | -0.8558 | -0.2891 |
| Monroe, LA | 0.0147 | -0.0212 | 0.1129 | 172579 | 71795 | 18785 | -0.0695 | 0.8069 | -1.2022 | 0.1432 | -0.4371 | 0.4080 | -0.6665 | 2.0020 |
| Montgomery, AL | 0.0461 | 0.0712 | 0.1616 | 362883 | 158730 | 21931 | -0.0511 | 1.2577 | -0.0556 | -1.4652 | -0.2019 | -0.7266 | -1.0279 | 0.0839 |
| Morgantown, WV | 0.0506 | 0.0467 | 0.2027 | 116970 | 51946 | 19816 | 2.0273 | 0.9768 | -0.7610 | 0.5530 | -0.3408 | 0.8410 | 1.7555 | 0.0023 |
| Morristown, WV | 0.0712 | 0.0823 | 0.1273 | 132168 | 61922 | 19166 | -0.6828 | -5.3019 | -0.0552 | 1.0323 | -0.5604 | -1.2490 | 1.4553 | -0.6875 |

Continued.

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions, Continued.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Myrtle Beach-Conway-North Myrtle Beach, SC | 0.1983 | 0.1869 | 0.1776 | 239754 | 117624 | 23827 | -0.5518 | -0.0645 | 0.8112 | 0.9613 | 2.0056 | 1.6272 | 1.4494 | -0.1340 |
| Naples-Marco Island, FL | 0.2198 | 0.2849 | 0.1050 | 313167 | 140184 | 34650 | -0.4397 | 1.8882 | 0.6185 | 3.0806 | 2.6236 | 2.0484 | 2.2487 | 1.0534 |
| Nashville-Davidson-Murfeesboro-Franklin, TN | 0.1252 | 0.0897 | 0.1417 | 1486695 | 730664 | 25853 | 0.0251 | 1.0129 | 1.0021 | 1.6329 | 0.7208 | -1.0865 | -1.9554 | 0.5975 |
| New Orleans-Metairie-Kenner, LA | -0.2846 | -0.2277 | 0.1964 | 990478 | 454709 | 23008 | 0.0361 | 2.0904 | -0.7464 | -0.2277 | -0.8036 | -0.8128 | -0.7076 | 0.6843 |
| Ocala, FL | 0.1939 | 0.2638 | 0.1600 | 314312 | 127900 | 20945 | -0.5902 | -0.7223 | -0.4434 | 0.6795 | 1.1535 | 1.4578 | -0.9442 | -0.5703 |
| Odessa, TX | 0.0446 | 0.1471 | 0.1903 | 126649 | 57956 | 18182 | -0.5281 | -1.0633 | -1.0667 | 0.3790 | -1.3774 | 1.0808 | 0.6502 | 0.8151 |
| Oklahoma City, OK | 0.0709 | 0.0874 | 0.1828 | 1175937 | 565269 | 23162 | 0.1734 | 2.3683 | 0.5721 | 1.5548 | 0.1516 | 0.1799 | -1.0158 | 0.1455 |
| Orlando-Kissimmee, FL | 0.1948 | 0.2052 | 0.1751 | 1998347 | 984116 | 25295 | -0.1600 | 2.1603 | 1.1465 | -0.1073 | 2.0747 | -0.7987 | 0.1423 | 0.8517 |
| Owensboro, KY | 0.0137 | -0.0034 | 0.1886 | 111386 | 50948 | 22139 | -0.4456 | -1.7867 | -0.1222 | 1.0218 | -1.5044 | -0.3054 | -0.7087 | -0.2840 |
| Palm Bay-Melbourne-Titus, FL | 0.1107 | 0.1577 | 0.1763 | 531959 | 242788 | 25626 | 0.1567 | 3.0377 | 1.0996 | -0.4997 | 1.5702 | 0.5092 | 0.1932 | 1.6022 |
| Palm Coast, FL | 0.5033 | 0.7120 | 0.1532 | 82433 | 38345 | 25500 | -0.4172 | 0.7323 | 0.0961 | -2.7588 | 3.6431 | 2.5042 | 0.0604 | -0.7220 |
| Panama City-Lynn Haven, FL | 0.1023 | 0.1633 | 0.2455 | 164184 | 76395 | 23904 | -0.2758 | 1.3099 | 0.4657 | 0.2632 | 0.9675 | 1.1386 | 0.3322 | -0.9121 |
| Parkersburg-Marietta-Vienna, WV-OH | -0.0221 | -0.0159 | 0.1534 | 161024 | 71034 | 20842 | -0.3747 | -0.6244 | 0.1706 | 0.9576 | -1.4495 | 0.1081 | -0.9254 | -1.2225 |
| Pascagoula, MS | -0.0060 | -0.0117 | 0.1816 | 149666 | 63141 | 20783 | -0.2878 | -1.2904 | -0.3893 | -1.6169 | -0.1211 | 0.3708 | 0.1036 | 0.1575 |
| Pensacola-Ferry Pass-Brent, FL | 0.0905 | 0.1080 | 0.1673 | 451190 | 189532 | 22524 | -0.0530 | 1.6337 | 0.2937 | -0.9447 | 0.8186 | 0.4595 | -0.2584 | -0.7685 |
| Pine Bluff, AR | -0.0430 | -0.0009 | 0.1848 | 102823 | 41439 | 18063 | -0.4934 | -1.8998 | -1.4840 | -2.4509 | -1.3327 | 0.6222 | -0.4021 | 0.2942 |
| Port St. Lucie, FL | 0.1961 | 0.3171 | 0.1629 | 388637 | 176998 | 27153 | -0.4438 | 0.9104 | 0.0424 | 0.4255 | 2.1365 | 1.7324 | 0.4440 | -0.0769 |
| Punta Gorda, FL | 0.0775 | 0.2048 | 0.1964 | 153047 | 62210 | 26538 | -0.4895 | 0.8276 | 0.0440 | 2.6136 | 1.8037 | 2.4281 | 1.6779 | -0.5157 |
| Raleigh-Cary, NC | 0.2274 | 0.1834 | 0.1086 | 1000577 | 511516 | 28075 | 1.0408 | 4.6560 | 1.8652 | 0.6319 | 1.1215 | -0.5629 | -1.4397 | 1.0614 |
| Richmond, VA | 0.0858 | 0.1012 | 0.1635 | 1195263 | 598515 | 27316 | 0.0502 | 1.8462 | 1.3039 | -1.3305 | 0.0878 | -0.8572 | -0.7304 | 1.0494 |
| Roanoke, VA | 0.0211 | 0.0351 | 0.1559 | 294454 | 146981 | 24550 | -0.3446 | -0.1742 | 1.2108 | 0.1385 | -0.6180 | -1.0983 | -1.3925 | 0.0209 |
| Rocky Mount, NC | 0.0107 | 0.0280 | 0.1115 | 144562 | 64096 | 19164 | -0.6725 | -3.4856 | 0.1986 | -2.1159 | -0.4136 | -1.5163 | 0.5653 | -0.4092 |
| Rome, GA | 0.0486 | 0.0297 | 0.0637 | 95076 | 41622 | 18980 | -0.3058 | -2.2833 | 0.1470 | -1.1131 | -0.4349 | -0.9085 | 0.6925 | 0.3821 |
| Salisbury, MD | 0.0781 | 0.0778 | 0.2203 | 118279 | 55754 | 22991 | -0.2055 | -0.4105 | 0.4679 | 0.1863 | -0.6151 | 0.3927 | -0.7159 | -0.4383 |
| San Angelo, TX | 0.0176 | 0.0046 | 0.1697 | 107659 | 46482 | 20592 | -0.1774 | 0.6129 | -0.4752 | 2.0432 | -1.0324 | 0.9408 | -0.5331 | -0.7193 |

Continued.

Table D.1. Values of Competitiveness Outcome Changes, 2006 Outcomes Values, and 1990 Initial Conditions, Continued.

| Metropolitan Statistical Area | Ln(Population06/Population00) | Ln(Employment06/Employment00) | Ln(Per Capita Income06/Per Capita Income00) | Population, 2006 | Employment, 2006 | Per Capita Income, 2006 | Innovation Inputs Factor, 1990 | Knowledge Workers Factor, 1990 | Labor Employability Factor, 1990 | Entrepreneurial Environment Factor, 1990 | Establishment Age and Churning Factor, 1990 | Business Size and Competitiveness Factor, 1990 | Industrustial Specialization, 1990 | Relative Industry Wage, 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| San Antonio, TX | 0.1235 | 0.1557 | 0.1472 | 1936750 | 861512 | 21367 | -0.0617 | 1.7343 | -0.7833 | 0.7339 | 0.5045 | -0.2817 | -0.6988 | -0.1082 |
| Sarasota-Bradenton-Venice, FL | 0.1428 | 0.2132 | 0.1283 | 680500 | 305968 | 29182 | -0.3368 | 1.9279 | 0.4729 | 1.7515 | 1.6431 | 1.1976 | 0.3271 | 0.2440 |
| Savannah, GA | 0.0928 | 0.1080 | 0.1243 | 321490 | 145058 | 23499 | -0.2553 | 0.5984 | 0.0441 | -1.8170 | 0.2494 | -0.4395 | -0.6902 | -0.1332 |
| Sebastian-Vero Beach, FL | 0.1372 | 0.1957 | 0.1896 | 129562 | 55328 | 32911 | -0.4017 | 1.9151 | 0.0145 | 1.4348 | 0.9529 | 1.9734 | 0.8279 | -0.8690 |
| Sherman-Denison, TX | 0.0571 | 0.1098 | 0.0987 | 117091 | 56697 | 20819 | -0.2849 | -1.0405 | 0.0263 | 0.9184 | -0.3583 | 0.4073 | -0.6829 | -0.2317 |
| Shreveport-Bossier City, LA | 0.0294 | 0.0722 | 0.1587 | 387183 | 169005 | 20657 | -0.2629 | 0.6907 | -1.0240 | 0.0145 | -1.0096 | -0.1198 | -0.8957 | -0.1091 |
| Spartanburg, SC | 0.0615 | 0.0606 | 0.1426 | 269902 | 127403 | 21610 | -0.4550 | -2.9277 | 0.5145 | -0.9744 | -0.2836 | -1.3676 | 1.0180 | 1.0727 |
| Sumter, SC | -0.0053 | -0.0453 | 0.1846 | 104094 | 39539 | 18832 | -0.4316 | -2.3639 | -0.2058 | -2.9325 | -0.7235 | -0.5719 | 0.0990 | -1.0080 |
| Tallahassee, FL | 0.0820 | 0.0560 | 0.1630 | 347672 | 166023 | 23193 | 1.5392 | 4.3701 | 0.4885 | -1.2287 | 0.7474 | 0.5701 | 1.6207 | 0.1248 |
| Tampa-St. Petersburg-Clearwater, FL | 0.1172 | 0.1510 | 0.1590 | 2694038 | 1255652 | 25537 | -0.2070 | 1.7797 | 0.4525 | -0.0162 | 1.5061 | 0.0664 | -0.5816 | 0.0746 |
| Texarkana, TX | 0.0315 | 0.0862 | 0.1696 | 133903 | 57560 | 20228 | -0.4342 | -1.3513 | -0.5132 | 0.2123 | -0.3960 | 0.4273 | -0.4303 | -1.1346 |
| Tulsa, OK | 0.0383 | 0.0381 | 0.1391 | 893053 | 424096 | 22663 | -0.1804 | 1.8818 | 0.6429 | 2.9929 | 0.0557 | -0.2592 | -1.0913 | 1.1465 |
| Tuscaloosa, AL | 0.0540 | 0.0755 | 0.1841 | 202686 | 89888 | 21824 | 0.7449 | -0.7156 | -0.7736 | -1.6625 | -0.0564 | -0.3037 | 0.7827 | 0.1011 |
| Tyler, TX | 0.1089 | 0.1154 | 0.1395 | 194798 | 86996 | 21926 | -0.0961 | 1.5834 | -0.0950 | 2.1110 | -0.3718 | 0.7438 | -1.3250 | 0.3153 |
| Valdosta, GA | 0.0709 | 0.1327 | 0.1085 | 128347 | 58001 | 17945 | -0.1700 | -1.7294 | -0.5195 | -1.6900 | -0.0076 | 0.5608 | -0.0997 | -1.3194 |
| Victoria, TX | 0.0093 | 0.0806 | 0.1488 | 112708 | 53825 | 20968 | -0.4484 | -0.8385 | -0.5275 | 1.5902 | -1.4420 | 1.3796 | 0.1285 | -1.0810 |
| Virginia Beach-Norfolk-Newport News, VA-NC | 0.0523 | 0.1283 | 0.2361 | 1660990 | 779342 | 25722 | 0.0260 | 1.9963 | 0.9955 | -2.2810 | 0.1800 | -0.4861 | -0.9895 | 0.2674 |
| Waco, TX | 0.0577 | 0.0555 | 0.0439 | 226206 | 99449 | 17944 | 0.0657 | 0.1900 | -0.6442 | 0.2446 | -0.6750 | -0.3876 | -1.6033 | 0.0682 |
| Warner Robins, GA | 0.1452 | 0.1635 | 0.1675 | 128070 | 57293 | 23073 | -0.1928 | 0.6421 | 1.2553 | -1.6533 | 0.3726 | 1.2472 | 1.2176 | -0.0359 |
| Weirton-Steubenville, WV-OH | -0.0630 | -0.0114 | 0.1235 | 123943 | 54142 | 19133 | -0.5605 | -3.5378 | -0.4510 | -0.6363 | -2.2506 | -0.1398 | 1.4537 | 1.3486 |
| Wheeling, WV-OH | -0.0449 | 0.0243 | 0.1286 | 146454 | 65109 | 19047 | -0.3787 | -0.8575 | -0.5120 | 0.3641 | -2.0338 | 0.3817 | -0.0664 | -0.1358 |
| Wichita Falls, TX | -0.0137 | -0.0422 | 0.2034 | 149455 | 61394 | 20906 | -0.2707 | 0.5439 | 0.1747 | 3.0418 | -0.7743 | 1.3882 | -0.8884 | 0.2400 |
| Wilmington, NC | 0.1815 | 0.1758 | 0.1843 | 329175 | 156755 | 25814 | -0.3107 | 0.3067 | 0.5683 | 0.8830 | 1.1813 | 0.9872 | -0.3214 | -0.8246 |
| Winchester, VA-WV | 0.1442 | 0.1364 | 0.2021 | 118973 | 59212 | 24144 | -0.5479 | -1.1632 | 0.8576 | 1.6370 | -0.7650 | -0.0668 | -0.6077 | 0.3736 |
| Winston-Salem, NC | 0.0755 | 0.0730 | 0.0948 | 455043 | 223433 | 24171 | -0.0124 | 0.1737 | 1.2032 | 0.4200 | 0.0038 | -1.1057 | -0.3964 | -0.3956 |

Table E.1. Estimation Results of Glaeser et al. Model Specification with the Interaction of Innovation Inputs and Business Size/Competitiveness.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -- | 0.0127 * | -- | -- | -- |
| | | | (1.89) | | | |
| Per capita income, 2000 | -- | -- | -0.0186 *** | -- | -- | -- |
| | | | (-2.96) | | | |
| Innovation inputs factor, 1990 | -- | -- | 0.0118 ** | -- | -- | -- |
| | | | (2.42) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | -- |
| Labor employability factor, 1990 | -- | -- | 0.0193 *** | -- | -- | -- |
| | | | (3.53) | | | |
| Entrepreneurial environment factor, 1990 | -- | -- | 0.0007 | -- | -- | -- |
| | | | (0.21) | | | |
| Establishment age and churning factor, 1990 | -- | -- | -0.0035 | -- | -- | -- |
| | | | (-0.60) | | | |
| Business size and competitiveness factor, 1990 | -- | -- | 0.0302 *** | -- | -- | -- |
| | | | (5.17) | | | |
| Industrustial specialization, 1990 | -- | -- | -0.0044 | -- | -- | -- |
| | | | (-0.87) | | | |
| Relative industry wage, 1990 | -- | -- | -0.0002 | -- | -- | -- |
| | | | (-0.03) | | | |
| Innovation x SmallBusinesses | -- | -- | -0.0119 * | -- | -- | -- |
| | | | (-1.95) | | | |
| Constant | -- | -- | -0.0058 | -- | -- | -- |
| | | | (-0.07) | | | |
| $R^2$ | -- | -- | 0.2720 | -- | -- | -- |

Notes: The number of observations is 151; t-statististics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.2. Estimation Results of Glaeser et al. Model Specification with the Interaction of Knowledge Workers and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -- | -- | -- | -- | 0.0059 |
| | | | | | | (0.83) |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -0.0208 *** |
| | | | | | | (-3.34) |
| Innovation inputs factor, 1990 | -- | -- | -- | -- | -- | -- |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | 0.0079 *** |
| | | | | | | (2.64) |
| Labor employability factor, 1990 | -- | -- | -- | -- | -- | 0.0166 *** |
| | | | | | | (2.96) |
| Entrepreneurial environment factor, 1990 | -- | -- | -- | -- | -- | 0.0007 |
| | | | | | | (0.27) |
| Establishment age and churning factor, 1990 | -- | -- | -- | -- | -- | -0.0031 |
| | | | | | | (-0.55) |
| Business size and competitiveness factor, 1990 | -- | -- | -- | -- | -- | 0.0185 *** |
| | | | | | | (2.67) |
| Industrustial specialization, 1990 | -- | -- | -- | -- | -- | 0.0020 |
| | | | | | | (0.41) |
| Relative industry wage, 1990 | -- | -- | -- | -- | -- | -0.0010 |
| | | | | | | (-0.19) |
| KnowledgeWorkers x IndustrialSpecialization | -- | -- | -- | -- | -- | 0.0031 *** |
| | | | | | | (2.62) |
| Constant | -- | -- | -- | -- | -- | 0.0816 |
| | | | | | | (0.90) |
| $R^2$ | -- | -- | -- | -- | -- | 0.3342 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.3. Estimation Results of Glaeser et al. Model Specification with the Interaction of Labor Employability and Business Size/Competitiveness.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0329 *** | -0.0264 * | 0.0123 * | -0.0314 *** | -0.0225 | 0.0045 |
| | (-2.82) | (-1.72) | (1.76) | (-2.86) | (-1.54) | (0.66) |
| Per capita income, 2000 | 0.0163 * | 0.0228 ** | -0.0167 ** | 0.0171 * | 0.0239 ** | -0.0196 *** |
| | (1.76) | (2.28) | (-2.43) | (1.83) | (2.45) | (-3.12) |
| Innovation inputs factor, 1990 | 0.0027 | -0.0105 *** | 0.0088 * | -- | -- | -- |
| | (1.03) | (-2.91) | (1.73) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0015 | -0.0056 * | 0.0101 *** |
| | | | | (-0.65) | (-1.75) | (3.93) |
| Labor employability factor, 1990 | -0.0006 | -0.0202 ** | 0.0125 * | -0.0009 | -0.0187 * | 0.0110 * |
| | (-0.06) | (-2.08) | (1.90) | (-0.09) | (-1.96) | (1.74) |
| Entrepreneurial environment factor, 1990 | 0.0021 | -0.0023 | 0.0009 | 0.0020 | -0.0020 | 0.0006 |
| | (0.53) | (-0.48) | (0.28) | (0.52) | (-0.40) | (0.23) |
| Establishment age and churning factor, 1990 | 0.0687 *** | 0.0747 *** | -0.0005 | 0.0690 *** | 0.0761 *** | -0.0029 |
| | (7.35) | (5.87) | (-0.09) | (7.29) | (5.94) | (-0.51) |
| Business size and competitiveness factor, 1990 | -0.0152 ** | 0.0100 | 0.0275 *** | -0.0139 ** | 0.0155 * | 0.0180 ** |
| | (-2.46) | (1.19) | (4.10) | (-2.09) | (1.71) | (2.48) |
| Industrustial specialization, 1990 | -0.0084 | -0.0078 | -0.0054 | -0.0084 | -0.0115 | -0.0005 |
| | (-1.54) | (-0.99) | (-1.06) | (-1.49) | (-1.40) | (-0.10) |
| Relative industry wage, 1990 | -0.0014 | 0.0028 | 0.0018 | -0.0004 | 0.0042 | -0.0017 |
| | (-0.26) | (0.36) | (0.33) | (-0.07) | (0.51) | (-0.33) |
| LaborEmployability x SmallBusinesses | -0.0183 ** | -0.0202 ** | 0.0109 * | -0.0176 ** | -0.0198 *** | 0.0091 * |
| | (-2.37) | (-2.57) | (1.94) | (-2.37) | (-2.66) | (1.79) |
| Constant | 0.4810 *** | 0.4170 ** | 0.0034 | 0.4628 *** | 0.3681 ** | 0.0998 |
| | (3.30) | (2.15) | (0.04) | (3.36) | (1.99) | (1.14) |
| $R^2$ | 0.5798 | 0.6092 | 0.2726 | 0.5797 | 0.6073 | 0.3267 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.4. Estimation Results of Glaeser et al. Model Specification with the Interaction of Labor Employability and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -0.0234 | -- | -- | -0.0181 | -- |
| | | (-1.51) | | | (-1.23) | |
| Per capita income, 2000 | -- | 0.0221 ** | -- | -- | 0.0237 ** | -- |
| | | (2.12) | | | (2.32) | |
| Innovation inputs factor, 1990 | -- | -0.0149 *** | -- | -- | -- | -- |
| | | (-3.71) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0077 ** | -- |
| | | | | | (-2.24) | |
| Labor employability factor, 1990 | -- | -0.0247 *** | -- | -- | -0.0231 ** | -- |
| | | (-2.73) | | | (-2.55) | |
| Entrepreneurial environment factor, 1990 | -- | -0.0017 | -- | -- | -0.0012 | -- |
| | | (-0.36) | | | (-0.24) | |
| Establishment age and churning factor, 1990 | -- | 0.0734 *** | -- | -- | 0.0756 *** | -- |
| | | (5.36) | | | (5.50) | |
| Business size and competitiveness factor, 1990 | -- | 0.0046 | -- | -- | 0.0121 | -- |
| | | (0.59) | | | (1.43) | |
| Industrustial specialization, 1990 | -- | -0.0016 | -- | -- | -0.0073 | -- |
| | | (-0.20) | | | (-0.86) | |
| Relative industry wage, 1990 | -- | 0.0058 | -- | -- | 0.0074 | -- |
| | | (0.74) | | | (0.90) | |
| LaborEmployability x IndustrialSpecialization | -- | -0.0127 ** | -- | -- | -0.0110 ** | -- |
| | | (-2.01) | | | (-2.00) | |
| Constant | -- | 0.3836 * | -- | -- | 0.3165 * | -- |
| | | (1.95) | | | (1.71) | |
| $R^2$ | -- | 0.6020 | -- | -- | 0.5981 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.5. Estimation Results of Glaeser et al. Model Specification with the Interaction of Labor Employability and Relative Industry Wage.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0316 *** | -0.0251 | -- | -0.0293 *** | -0.0202 | -- |
| | (-2.66) | (-1.62) | | (-2.67) | (-1.38) | |
| Per capita income, 2000 | 0.0150 | 0.0214 ** | -- | 0.0162 * | 0.0228 ** | -- |
| | (1.58) | (1.98) | | (1.69) | (2.15) | |
| Innovation inputs factor, 1990 | 0.0013 | -0.0120 *** | -- | -- | -- | -- |
| | (0.41) | (-3.45) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0029 | -0.0071 ** | -- |
| | | | | (-1.06) | (-2.14) | |
| Labor employability factor, 1990 | -0.0010 | -0.0199 * | -- | -0.0005 | -0.0177 | -- |
| | (-0.09) | (-1.83) | | (-0.04) | (-1.64) | |
| Entrepreneurial environment factor, 1990 | 0.0025 | -0.0019 | -- | 0.0024 | -0.0016 | -- |
| | (0.64) | (-0.40) | | (0.63) | (-0.33) | |
| Establishment age and churning factor, 1990 | 0.0659 *** | 0.0712 *** | -- | 0.0664 *** | 0.0728 *** | -- |
| | (6.68) | (5.17) | | (6.71) | (5.27) | |
| Business size and competitiveness factor, 1990 | -0.0173 *** | 0.0080 | -- | -0.0143 ** | 0.0153 * | -- |
| | (-2.81) | (0.97) | | (-2.21) | (1.74) | |
| Industrustial specialization, 1990 | -0.0077 | -0.0072 | -- | -0.0086 | -0.0118 | -- |
| | (-1.40) | (-0.94) | | (-1.46) | (-1.45) | |
| Relative industry wage, 1990 | 0.0005 | 0.0049 | -- | 0.0018 | 0.0067 | -- |
| | (0.08) | (0.63) | | (0.32) | (0.82) | |
| LaborEmployability x RelativeIndWage | 0.0085 ** | 0.0101 ** | -- | 0.0087 ** | 0.0103 ** | -- |
| | (1.98) | (2.24) | | (2.05) | (2.25) | |
| Constant | 0.4656 *** | 0.4017 ** | -- | 0.4368 *** | 0.3402 * | -- |
| | (3.12) | (2.05) | | (3.16) | (1.84) | |
| $R^2$ | 0.5666 | 0.6008 | -- | 0.5692 | 0.6003 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.6. Estimation Results of Glaeser et al. Model Specification with the Interaction of Entrepreneurial Environment and Business Size/Competitiveness.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0307 *** | -- | 0.0110 | -0.0290 *** | -- | -- |
| | (-2.8) | | (1.65) | (-2.80) | | |
| Per capita income, 2000 | 0.0222 ** | -- | -0.0208 *** | 0.0229 ** | -- | -- |
| | (2.42) | | (-2.96) | (2.51) | | |
| Innovation inputs factor, 1990 | 0.0008 | -- | 0.0100 * | -- | -- | -- |
| | (0.27) | | (1.82) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0021 | -- | -- |
| | | | | (-0.80) | | |
| Labor employability factor, 1990 | -0.0131 * | -- | 0.0203 *** | -0.0128 | -- | -- |
| | (-1.68) | | (3.51) | (-1.62) | | |
| Entrepreneurial environment factor, 1990 | 0.0060 | -- | -0.0017 | 0.0059 | -- | -- |
| | (1.62) | | (-0.62) | (1.59) | | |
| Establishment age and churning factor, 1990 | 0.0669 *** | -- | 0.0009 | 0.0673 *** | -- | -- |
| | (7.62) | | (0.15) | (7.50) | | |
| Business size and competitiveness factor, 1990 | -0.0214 *** | -- | 0.0312 *** | -0.0194 *** | -- | -- |
| | (-3.47) | | (4.87) | (-3.04) | | |
| Industrustial specialization, 1990 | -0.0041 | -- | -0.0082 | -0.0047 | -- | -- |
| | (-0.81) | | (-1.58) | (-0.91) | | |
| Relative industry wage, 1990 | 0.0010 | -- | 0.0003 | 0.0019 | -- | -- |
| | (0.17) | | (0.06) | (0.33) | | |
| Entrepreneurship x SmallBusinesses | -0.0067 * | -- | 0.0046 * | -0.0065 * | -- | -- |
| | (-1.80) | | (1.77) | (-1.76) | | |
| Constant | 0.4603 *** | -- | 0.0143 | 0.4391 *** | -- | -- |
| | (3.32) | | (0.17) | (3.34) | | |
| $R^2$ | 0.5676 | -- | 0.2669 | 0.5690 | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.7. Estimation Results of Glaeser et al. Model Specification with the Interaction of Entrepreneurial Environment and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -- | 0.0111 | -- | -- | 0.0034 |
| | | | (1.60) | | | (0.47) |
| Per capita income, 2000 | -- | -- | -0.0248 *** | -- | -- | -0.0267 *** |
| | | | (-3.22) | | | (-3.94) |
| Innovation inputs factor, 1990 | -- | -- | 0.0109 * | -- | -- | -- |
| | | | (1.86) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | 0.0105 *** |
| | | | | | | (3.88) |
| Labor employability factor, 1990 | -- | -- | 0.0223 *** | -- | -- | 0.0193 *** |
| | | | (3.69) | | | (3.29) |
| Entrepreneurial environment factor, 1990 | -- | -- | -0.0009 | -- | -- | -0.0010 |
| | | | (-0.41) | | | (-0.46) |
| Establishment age and churning factor, 1990 | -- | -- | 0.0002 | -- | -- | -0.0024 |
| | | | (0.03) | | | (-0.43) |
| Business size and competitiveness factor, 1990 | -- | -- | 0.0317 *** | -- | -- | 0.0211 *** |
| | | | (5.05) | | | (3.00) |
| Industrustial specialization, 1990 | -- | -- | -0.0086 * | -- | -- | -0.0028 |
| | | | (-1.96) | | | (-0.61) |
| Relative industry wage, 1990 | -- | -- | 0.0029 | -- | -- | -0.0007 |
| | | | (0.57) | | | (-0.13) |
| Entrepreneurship x IndustrialSpecialization | -- | -- | 0.0074 *** | -- | -- | 0.0065 *** |
| | | | (3.82) | | | (3.77) |
| Constant | -- | -- | 0.0155 | -- | -- | 0.1126 |
| | | | (0.18) | | | (1.25) |
| $R^2$ | -- | -- | 0.2947 | -- | -- | 0.3459 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.8. Estimation Results of Glaeser et al. Model Specification with the Interaction of Entrepreneurial Environment and Establishment Age/Churning.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -0.0187 | -- | -- | -0.0129 | -- |
| | | (-1.55) | | | (-1.09) | |
| Per capita income, 2000 | -- | 0.0365 *** | -- | -- | 0.0384 *** | -- |
| | | (2.85) | | | (3.12) | |
| Innovation inputs factor, 1990 | -- | -0.0139 *** | -- | -- | -- | -- |
| | | (-4.01) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0084 ** | -- |
| | | | | | (-2.44) | |
| Labor employability factor, 1990 | -- | -0.0375 *** | -- | -- | -0.0353 *** | -- |
| | | (-3.97) | | | (-3.86) | |
| Entrepreneurial environment factor, 1990 | -- | -0.0002 | -- | -- | 0.0002 | -- |
| | | (-0.05) | | | (0.04) | |
| Establishment age and churning factor, 1990 | -- | 0.0697 *** | -- | -- | 0.0716 *** | -- |
| | | (7.16) | | | (7.43) | |
| Business size and competitiveness factor, 1990 | -- | 0.0022 | -- | -- | 0.0106 | -- |
| | | (0.28) | | | (1.22) | |
| Industrustial specialization, 1990 | -- | 0.0009 | -- | -- | -0.0044 | -- |
| | | (0.15) | | | (-0.68) | |
| Relative industry wage, 1990 | -- | 0.0022 | -- | -- | 0.0043 | -- |
| | | (0.28) | | | (0.53) | |
| Entrepreneurship x YoungEstablishments | -- | -0.0129 ** | -- | -- | -0.0131 ** | -- |
| | | (-2.15) | | | (-2.23) | |
| Constant | -- | 0.3260 ** | -- | -- | 0.2526 * | -- |
| | | (2.15) | | | (1.70) | |
| $R^2$ | -- | 0.6187 | -- | -- | 0.6184 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.9. Estimation Results of Glaeser et al. Model Specification with the Interaction of Business Size/Competitiveness and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0288 ** | -- | 0.0098 | -0.0278 ** | -- | -- |
| | (-2.56) | | (1.41) | (-2.58) | | |
| Per capita income, 2000 | 0.0205 ** | -- | -0.0195 *** | 0.0208 ** | -- | -- |
| | (2.17) | | (-2.67) | (2.17) | | |
| Innovation inputs factor, 1990 | 0.0033 | -- | 0.0084 | -- | -- | -- |
| | (0.99) | | (1.45) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0013 | -- | -- |
| | | | | (-0.46) | | |
| Labor employability factor, 1990 | -0.0113 | -- | 0.0189 *** | -0.0111 | -- | -- |
| | (-1.42) | | (3.20) | (-1.37) | | |
| Entrepreneurial environment factor, 1990 | 0.0025 | -- | 0.0007 | 0.0024 | -- | -- |
| | (0.65) | | (0.23) | (0.64) | | |
| Establishment age and churning factor, 1990 | 0.0700 *** | -- | -0.0013 | 0.0702 *** | -- | -- |
| | (7.22) | | (-0.21) | (7.11) | | |
| Business size and competitiveness factor, 1990 | -0.0168 *** | -- | 0.0282 *** | -0.0160 ** | -- | -- |
| | (-2.61) | | (4.49) | (-2.42) | | |
| Industrustial specialization, 1990 | -0.0097 | -- | -0.0045 | -0.0092 | -- | -- |
| | (-1.59) | | (-0.96) | (-1.48) | | |
| Relative industry wage, 1990 | -0.0012 | -- | 0.0017 | -0.0002 | -- | -- |
| | (-0.22) | | (0.32) | (-0.04) | | |
| SmallBusinesses x IndustrialSpecialization | -0.0083 ** | -- | 0.0054 * | -0.0074 * | -- | -- |
| | (-2.08) | | (1.79) | (-1.84) | | |
| Constant | 0.4363 *** | -- | 0.0304 | 0.4227 *** | -- | -- |
| | (3.07) | | (0.34) | (3.12) | | |
| $R^2$ | 0.5657 | -- | 0.2635 | 0.5649 | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.10. Estimation Results of Glaeser et al. Model Specification with the Interaction of Business Size/Competitiveness and Relative Industry Wage.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0341 *** | -- | -- | -0.0320 *** | -0.0227 | -- |
| | (-2.91) | | | (-2.94) | (-1.49) | |
| Per capita income, 2000 | 0.0188 * | -- | -- | 0.0199 ** | 0.0268 ** | -- |
| | (1.95) | | | (2.05) | (2.38) | |
| Innovation inputs factor, 1990 | 0.0022 | -- | -- | -- | -- | -- |
| | (0.79) | | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0025 | -0.0067 ** | -- |
| | | | | (-0.94) | (-2.02) | |
| Labor employability factor, 1990 | -0.0107 | -- | -- | -0.0105 | -0.0294 *** | -- |
| | (-1.39) | | | (-1.35) | (-3.38) | |
| Entrepreneurial environment factor, 1990 | 0.0044 | -- | -- | 0.0042 | 0.0004 | -- |
| | (1.15) | | | (1.13) | (0.08) | |
| Establishment age and churning factor, 1990 | 0.0701 *** | -- | -- | 0.0706 *** | 0.0778 *** | -- |
| | (7.24) | | | (7.22) | (5.96) | |
| Business size and competitiveness factor, 1990 | -0.0231 *** | -- | -- | -0.0206 *** | 0.0081 | -- |
| | (-3.85) | | | (-3.36) | (0.93) | |
| Industrustial specialization, 1990 | -0.0081 | -- | -- | -0.0085 | -0.0115 | -- |
| | (-1.56) | | | (-1.55) | (-1.41) | |
| Relative industry wage, 1990 | -0.0022 | -- | -- | -0.0009 | 0.0038 | -- |
| | (-0.42) | | | (-0.16) | (0.45) | |
| SmallBusinesses x RelativeIndWage | -0.0116 ** | -- | -- | -0.0114 ** | -0.0118 * | -- |
| | (-2.50) | | | (-2.53) | (-1.68) | |
| Constant | 0.4974 *** | -- | -- | 0.4704 *** | 0.3720 * | -- |
| | (3.39) | | | (3.45) | (1.94) | |
| $R^2$ | 0.5685 | -- | -- | 0.5699 | 0.5978 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.11. Estimation Results of Glaeser et al. Model Specification with the Interaction of Industrial Specialization and Establishment Age/Churning.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -0.0354 *** | -- | 0.0125 ** | -0.0341 *** | -- | -- |
| | (-2.95) | | (1.84) | (-2.94) | | |
| Per capita income, 2000 | 0.0229 ** | -- | -0.0193 *** | 0.0235 ** | -- | -- |
| | (2.44) | | (-2.62) | (2.52) | | |
| Innovation inputs factor, 1990 | 0.0013 | -- | 0.0096 * | -- | -- | -- |
| | (0.45) | | (1.74) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0014 | -- | -- |
| | | | | (-0.54) | | |
| Labor employability factor, 1990 | -0.0143 * | -- | 0.0196 *** | -0.0140 * | -- | -- |
| | (-1.77) | | (3.30) | (-1.73) | | |
| Entrepreneurial environment factor, 1990 | 0.0029 | -- | 0.0004 | 0.0028 | -- | -- |
| | (0.78) | | (0.11) | (0.78) | | |
| Establishment age and churning factor, 1990 | 0.0743 *** | -- | -0.0029 | 0.0744 *** | -- | -- |
| | (7.63) | | (-0.49) | (7.61) | | |
| Business size and competitiveness factor, 1990 | -0.0185 *** | -- | 0.0301 *** | -0.0171 *** | -- | -- |
| | (-3.12) | | (4.78) | (-2.70) | | |
| Industrustial specialization, 1990 | -0.0093 * | -- | -0.0056 | -0.0096 * | -- | -- |
| | (-1.75) | | (-1.11) | (-1.70) | | |
| Relative industry wage, 1990 | -0.0007 | -- | 0.0013 | 0.0000 | -- | -- |
| | (-0.14) | | (0.23) | (0.01) | | |
| IndustrialSpecialization x YoungEstablishments | -0.0169 *** | -- | 0.0065 * | -0.0166 *** | -- | -- |
| | (-2.84) | | (1.67) | (-2.80) | | |
| Constant | 0.5181 *** | -- | -0.0033 | 0.5021 *** | -- | -- |
| | (3.43) | | (-0.04) | (3.43) | | |
| $R^2$ | 0.5839 | -- | 0.2615 | 0.5843 | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.12. Estimation Results of Glaeser et al. Model Specification with the Interaction of Industrial Specialization and Relative Industry Wage.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -- | 0.0089 | -- | -- | -- |
| | | | (1.26) | | | |
| Per capita income, 2000 | -- | -- | -0.0159 *** | -- | -- | -- |
| | | | (-2.63) | | | |
| Innovation inputs factor, 1990 | -- | -- | 0.0081 | -- | -- | -- |
| | | | (1.50) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | -- |
| Labor employability factor, 1990 | -- | -- | 0.0178 *** | -- | -- | -- |
| | | | (3.24) | | | |
| Entrepreneurial environment factor, 1990 | -- | -- | 0.0001 | -- | -- | -- |
| | | | (0.03) | | | |
| Establishment age and churning factor, 1990 | -- | -- | -0.0024 | -- | -- | -- |
| | | | (-0.40) | | | |
| Business size and competitiveness factor, 1990 | -- | -- | 0.0311 *** | -- | -- | -- |
| | | | (5.01) | | | |
| Industrustial specialization, 1990 | -- | -- | -0.0045 | -- | -- | -- |
| | | | (-1.01) | | | |
| Relative industry wage, 1990 | -- | -- | 0.0027 | -- | -- | -- |
| | | | (0.49) | | | |
| IndustrialSpecialization x RelativeIndWage | -- | -- | -0.0067 ** | -- | -- | -- |
| | | | (-2.01) | | | |
| Constant | -- | -- | 0.0429 | -- | -- | -- |
| | | | (0.48) | | | |
| $R^2$ | -- | -- | 0.2637 | -- | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at $p<0.01$; ** denotes significance at $p<0.05$; and * denotes significance at $p<0.10$.

Table E.13. Estimation Results of Glaeser et al. Model Specification with the Interaction of Relative Industry Wage and Establishment Age/Churning.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(P_{06}/P_{00})$ | $\ln(E_{06}/E_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population, 2000 | -- | -- | -- | -- | -- | 0.0034 |
| | | | | | | (0.47) |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -0.0176 *** |
| | | | | | | (-3.27) |
| Innovation inputs factor, 1990 | -- | -- | -- | -- | -- | -- |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | 0.0110 *** |
| | | | | | | (3.94) |
| Labor employability factor, 1990 | -- | -- | -- | -- | -- | 0.0161 *** |
| | | | | | | (3.12) |
| Entrepreneurial environment factor, 1990 | -- | -- | -- | -- | -- | 0.0004 |
| | | | | | | (0.16) |
| Establishment age and churning factor, 1990 | -- | -- | -- | -- | -- | -0.0049 |
| | | | | | | (-0.88) |
| Business size and competitiveness factor, 1990 | -- | -- | -- | -- | -- | 0.0203 *** |
| | | | | | | (2.97) |
| Industrustial specialization, 1990 | -- | -- | -- | -- | -- | -0.0014 |
| | | | | | | (-0.27) |
| Relative industry wage, 1990 | -- | -- | -- | -- | -- | -0.0044 |
| | | | | | | (-0.84) |
| RelativeIndWage x YoungEstablishments | -- | -- | -- | -- | -- | -0.0066 * |
| | | | | | | (-1.77) |
| Constant | -- | -- | -- | -- | -- | 0.1127 |
| | | | | | | (1.24) |
| $R^2$ | -- | -- | -- | -- | -- | 0.3216 |

Notes: The number of observations is 151; t-statististics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.14. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Knowledge Workers and Business Size/Competitiveness.

| Factor | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | -- | -- | -- | 0.8236 *** | -- |
| | | | | | (11.91) | |
| Log population/sq. mile, 2000 | -- | -- | -- | -0.6206 *** | -- | -- |
| | | | | (-17.83) | | |
| Log employment/sq. mile, 2006 | -- | -- | -- | 0.6247 *** | -- | -- |
| | | | | (17.64) | | |
| Log employment/sq. mile, 2000 | -- | -- | -- | -- | -0.8306 *** | -- |
| | | | | | (-11.91) | |
| Per capita income, 2006 | -- | -- | -- | -0.1585 *** | 0.2849 *** | -- |
| | | | | (-3.48) | (4.34) | |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -- |
| Innovation inputs factor, 1990 | -- | -- | -- | -- | -- | -- |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0007 | -0.0043 | -- |
| | | | | (-0.37) | (-1.43) | |
| Labor employability factor, 1990 | -- | -- | -- | -0.0020 | -0.0042 | -- |
| | | | | (-0.40) | (-0.53) | |
| Entrepreneurial environment factor, 1990 | -- | -- | -- | -0.0094 *** | 0.0141 *** | -- |
| | | | | (-4.31) | (4.27) | |
| Establishment age and churning factor, 1990 | -- | -- | -- | 0.0239 *** | 0.0127 | -- |
| | | | | (5.02) | (1.61) | |
| Business size and competitiveness factor, 1990 | -- | -- | -- | 0.0214 *** | -0.0304 *** | -- |
| | | | | (4.55) | (-4.04) | |
| Industrustial specialization, 1990 | -- | -- | -- | -0.0046 | 0.0077 | -- |
| | | | | (-1.17) | (1.31) | |
| Relative industry wage, 1990 | -- | -- | -- | -0.0046 | 0.0044 | -- |
| | | | | (-1.23) | (0.80) | |
| KnowWorkers x SmallBusinesses | -- | -- | -- | 0.0031 * | -0.0055 ** | -- |
| | | | | (1.72) | (-2.07) | |
| Constant | -- | -- | -- | 2.0880 *** | -3.4562 *** | -- |
| | | | | (4.56) | (-5.26) | |
| "$R^2$" | -- | -- | -- | 0.8319 | 0.7705 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at $p<0.01$; ** denotes significance at $p<0.05$; and * denotes significance at $p<0.10$.

Table E.15. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Knowledge Workers and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | -- | -- | -- | -- | -0.2032 ** |
| | | | | | | (-2.23) |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | -- | -- | -- | 0.2030 ** |
| | | | | | | (2.21) |
| Log employment/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Per capita income, 2006 | -- | -- | -- | -- | -- | -- |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -0.1797 *** |
| | | | | | | (-3.16) |
| Innovation inputs factor, 1990 | -- | -- | -- | -- | -- | -- |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | 0.0085 *** |
| | | | | | | (3.22) |
| Labor employability factor, 1990 | -- | -- | -- | -- | -- | 0.0162 *** |
| | | | | | | (2.70) |
| Entrepreneurial environment factor, 1990 | -- | -- | -- | -- | -- | -0.0026 |
| | | | | | | (-0.85) |
| Establishment age and churning factor, 1990 | -- | -- | -- | -- | -- | -0.0019 |
| | | | | | | (-0.33) |
| Business size and competitiveness factor, 1990 | -- | -- | -- | -- | -- | 0.0223 *** |
| | | | | | | (3.34) |
| Industrustial specialization, 1990 | -- | -- | -- | -- | -- | -0.0004 |
| | | | | | | (-0.10) |
| Relative industry wage, 1990 | -- | -- | -- | -- | -- | -0.0015 |
| | | | | | | (-0.28) |
| KnowWorkers x IndustrialSpecialization | -- | -- | -- | -- | -- | 0.0027 ** |
| | | | | | | (1.94) |
| Constant | -- | -- | -- | -- | -- | 2.0864 *** |
| | | | | | | (3.57) |
| "$R^2$" | -- | -- | -- | -- | -- | 0.3336 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.16. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Labor Employability and Business Size/Competitiveness.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8792 *** | -0.2380 ** | -- | 0.7991 *** | -0.2499 *** |
| | | (12.05) | (-2.28) | | (11.67) | (-2.72) |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | 0.2422 ** | -- | -- | 0.2510 *** |
| | | | (2.30) | | | (2.69) |
| Log employment/sq. mile, 2000 | -- | -0.8887 *** | -- | -- | -0.8089 *** | -- |
| | | (-12.17) | | | (-11.74) | |
| Per capita income, 2006 | -- | 0.2696 *** | -- | -- | 0.3095 *** | -- |
| | | (4.23) | | | (4.73) | |
| Per capita income, 2000 | -- | -- | -0.1701 *** | -- | -- | -0.1979 *** |
| | | | (-2.81) | | | (-3.44) |
| Innovation inputs factor, 1990 | -- | 0.0111 ** | 0.0054 | -- | -- | -- |
| | | (2.16) | (1.15) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0032 | 0.0101 *** |
| | | | | | (-1.07) | (4.13) |
| Labor employability factor, 1990 | -- | 0.0045 | 0.0099 | -- | -0.0023 | 0.0100 |
| | | (0.57) | (1.46) | | (-0.30) | (1.58) |
| Entrepreneurial environment factor, 1990 | -- | 0.0128 *** | -0.0023 | -- | 0.0106 *** | -0.0029 |
| | | (3.86) | (-0.71) | | (3.27) | (-0.95) |
| Establishment age and churning factor, 1990 | -- | 0.0053 | 0.0038 | -- | 0.0115 | -0.0011 |
| | | (0.68) | (0.64) | | (1.47) | (-0.19) |
| Business size and competitiveness factor, 1990 | -- | -0.0270 *** | 0.0293 *** | -- | -0.0229 *** | 0.0222 *** |
| | | (-3.67) | (4.40) | | (-2.98) | (3.38) |
| Industrustial specialization, 1990 | -- | -0.0005 | -0.0091 ** | -- | 0.0003 | -0.0023 |
| | | (-0.10) | (-2.16) | | (0.06) | (-0.54) |
| Relative industry wage, 1990 | -- | 0.0013 | 0.0044 | -- | 0.0026 | -0.0016 |
| | | (0.25) | (0.87) | | (0.47) | (-0.32) |
| LaborEmployability x SmallBusinesses | -- | -0.0160 *** | 0.0138 ** | -- | -0.0161 *** | 0.0127 ** |
| | | (-2.76) | (2.47) | | (-2.78) | (2.42) |
| Constant | -- | -3.3491 *** | 2.0025 *** | -- | -3.6744 *** | 2.2990 *** |
| | | (-5.26) | (3.19) | | (-5.61) | (3.88) |
| "$R^2$" | -- | 0.7764 | 0.2614 | -- | 0.7771 | 0.3351 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.17. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Labor Employability and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8854 *** | -- | -- | 0.8155 *** | -- |
| | | (12.03) | | | (11.92) | |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2000 | -- | -0.8898 *** | -- | -- | -0.8193 *** | -- |
| | | (-12.04) | | | (-11.88) | |
| Per capita income, 2006 | -- | 0.2289 *** | -- | -- | 0.2688 *** | -- |
| | | (3.61) | | | (4.14) | |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -- |
| Innovation inputs factor, 1990 | -- | 0.0090 * | -- | -- | -- | -- |
| | | (1.69) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0039 | -- |
| | | | | | (-1.32) | |
| Labor employability factor, 1990 | -- | 0.0037 | -- | -- | -0.0016 | -- |
| | | (0.45) | | | (-0.20) | |
| Entrepreneurial environment factor, 1990 | -- | 0.0141 *** | -- | -- | 0.0121 *** | -- |
| | | (4.29) | | | (3.80) | |
| Establishment age and churning factor, 1990 | -- | 0.0056 | -- | -- | 0.0106 | -- |
| | | (0.70) | | | (1.34) | |
| Business size and competitiveness factor, 1990 | -- | -0.0303 *** | -- | -- | -0.0253 *** | -- |
| | | (-4.14) | | | (-3.35) | |
| Industrustial specialization, 1990 | -- | 0.0022 | -- | -- | 0.0027 | -- |
| | | (0.45) | | | (0.57) | |
| Relative industry wage, 1990 | -- | 0.0053 | -- | -- | 0.0071 | -- |
| | | (0.97) | | | (1.29) | |
| LaborEmployability x IndustrialSpecialization | -- | -0.0083 * | -- | -- | -0.0106 ** | -- |
| | | (-1.83) | | | (-2.42) | |
| Constant | -- | -2.9663 *** | -- | -- | -3.3057 *** | -- |
| | | (-4.66) | | | (-5.08) | |
| "$R^2$" | -- | 0.7706 | -- | -- | 0.7747 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.18. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Entrepreneurial Environment and Business Size/Competitiveness.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8901 *** | -0.2182 ** | -- | 0.8181 *** | -0.2407 ** |
| | | (12.03) | (-2.09) | | (11.82) | (-2.57) |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | 0.2212 ** | -- | -- | 0.2404 ** |
| | | | (2.10) | | | (2.53) |
| Log employment/sq. mile, 2000 | -- | -0.8983 *** | -- | -- | -0.8267 *** | -- |
| | | (-12.12) | | | (-11.85) | |
| Per capita income, 2006 | -- | 0.2896 *** | -- | -- | 0.3344 *** | -- |
| | | (4.19) | | | (4.77) | |
| Per capita income, 2000 | -- | -- | -0.1857 *** | -- | -- | -0.2096 *** |
| | | | (-2.90) | | | (-3.43) |
| Innovation inputs factor, 1990 | -- | 0.0096 * | 0.0071 | -- | -- | -- |
| | | (1.83) | (1.51) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0033 | 0.0102 *** |
| | | | | | (-1.10) | (4.17) |
| Labor employability factor, 1990 | -- | -0.0057 | 0.0193 *** | -- | -0.0126 | 0.0181 *** |
| | | (-0.66) | (2.91) | | (-1.53) | (2.89) |
| Entrepreneurial environment factor, 1990 | -- | 0.0170 *** | -0.0054 | -- | 0.0153 *** | -0.0057 * |
| | | (4.89) | (-1.50) | | (4.47) | (-1.69) |
| Establishment age and churning factor, 1990 | -- | 0.0046 | 0.0041 | -- | 0.0099 | -0.0011 |
| | | (0.58) | (0.68) | | (1.23) | (-0.18) |
| Business size and competitiveness factor, 1990 | -- | -0.0340 *** | 0.0338 *** | -- | -0.0302 *** | 0.0265 *** |
| | | (-4.71) | (5.13) | | (-4.02) | (4.04) |
| Industrustial specialization, 1990 | -- | 0.0026 | -0.0119 *** | -- | 0.0033 | -0.0043 |
| | | (0.54) | (-2.75) | | (0.69) | (-0.98) |
| Relative industry wage, 1990 | -- | 0.0047 | 0.0019 | -- | 0.0060 | -0.0039 |
| | | (0.86) | (0.37) | | (1.09) | (-0.78) |
| Entrepreneurship x SmallBusinesses | -- | -0.0060 ** | 0.0053 * | -- | -0.0068 ** | 0.0044 * |
| | | (-2.05) | (1.96) | | (-2.35) | (1.68) |
| Constant | -- | -3.5580 *** | 2.1399 *** | -- | -3.9393 *** | 2.4080 *** |
| | | (-5.16) | (3.23) | | (-5.61) | (3.82) |
| "$R^2$" | -- | 0.7688 | 0.2532 | -- | 0.7700 | 0.3226 |

Notes: The number of observations is 151; t-statistictics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.19. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Entrpreneurial Environment and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | -- | -0.2125 ** | -- | 0.8239 *** | -0.2462 *** |
| | | | (-2.10) | | (11.80) | (-2.71) |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | 0.2138 ** | -- | -- | 0.2443 *** |
| | | | (2.09) | | | (2.66) |
| Log employment/sq. mile, 2000 | -- | -- | -- | -- | -0.8306 *** | -- |
| | | | | | (-11.81) | |
| Per capita income, 2006 | -- | -- | -- | -- | 0.3402 *** | -- |
| | | | | | (4.58) | |
| Per capita income, 2000 | -- | -- | -0.2086 *** | -- | | -0.2381 *** |
| | | | (-3.32) | | | (-3.96) |
| Innovation inputs factor, 1990 | -- | -- | 0.0081 * | -- | | -- |
| | | | (1.75) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0038 | 0.0105 *** |
| | | | | | (-1.25) | (4.38) |
| Labor employability factor, 1990 | -- | -- | 0.0217 *** | -- | -0.0127 | 0.0206 *** |
| | | | (3.30) | | (-1.49) | (3.34) |
| Entrepreneurial environment factor, 1990 | -- | -- | -0.0042 | -- | 0.0133 *** | -0.0050 * |
| | | | (-1.28) | | (4.10) | (-1.66) |
| Establishment age and churning factor, 1990 | -- | -- | 0.0035 | -- | 0.0114 | -0.0015 |
| | | | (0.60) | | (1.42) | (-0.26) |
| Business size and competitiveness factor, 1990 | -- | -- | 0.0337 *** | -- | -0.0303 *** | 0.0265 *** |
| | | | (5.22) | | (-4.00) | (4.13) |
| Industrustial specialization, 1990 | -- | -- | -0.0124 *** | -- | 0.0025 | -0.0047 |
| | | | (-2.94) | | (0.51) | (-1.11) |
| Relative industry wage, 1990 | -- | -- | 0.0049 | -- | 0.0037 | -0.0013 |
| | | | (0.97) | | (0.66) | (-0.27) |
| Entrepreneurship x IndustrialSpecialization | -- | -- | 0.0078 *** | -- | -0.0059 ** | 0.0074 *** |
| | | | (3.01) | | (-1.99) | (3.00) |
| Constant | -- | -- | 2.3708 *** | -- | -4.0129 *** | 2.7013 *** |
| | | | (3.65) | | (-5.38) | (4.37) |
| "$R^2$" | -- | -- | 0.2811 | -- | 0.7668 | 0.3503 |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.20. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Entrepreneurial Environment and Establishment Age/Churning.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8714 *** | -- | -- | 0.7987 *** | -- |
| | | (12.21) | | | (12.03) | |
| Log population/sq. mile, 2000 | -0.6441 *** | -- | -- | -0.6298 *** | -- | -- |
| | (-18.31) | | | (-17.59) | | |
| Log employment/sq. mile, 2006 | 0.6460 *** | -- | -- | 0.6324 *** | -- | -- |
| | (18.13) | | | (17.44) | | |
| Log employment/sq. mile, 2000 | -- | -0.8753 *** | -- | -- | -0.8018 *** | -- |
| | | (-12.22) | | | (-11.97) | |
| Per capita income, 2006 | -0.1886 *** | 0.3119 *** | -- | -0.1949 *** | 0.3690 *** | -- |
| | (-4.10) | (4.78) | | (-3.93) | (5.51) | |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -- |
| Innovation inputs factor, 1990 | -0.0076 ** | 0.0079 | -- | -- | -- | -- |
| | (-2.36) | (1.55) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0006 | -0.0052 * | -- |
| | | | | (-0.32) | (-1.80) | |
| Labor employability factor, 1990 | 0.0018 | -0.0094 | -- | 0.0032 | -0.0172 ** | -- |
| | (0.35) | (-1.15) | | (0.61) | (-2.18) | |
| Entrepreneurial environment factor, 1990 | -0.0099 *** | 0.0152 *** | -- | -0.0093 *** | 0.0134 *** | -- |
| | (-4.63) | (4.76) | | (-4.33) | (4.32) | |
| Establishment age and churning factor, 1990 | 0.0235 *** | 0.0054 | -- | 0.0246 *** | 0.0114 | -- |
| | (5.07) | (0.70) | | (5.20) | (1.50) | |
| Business size and competitiveness factor, 1990 | 0.0217 *** | -0.0351 *** | -- | 0.0221 *** | -0.0302 *** | -- |
| | (4.63) | (-5.02) | | (4.67) | (-4.20) | |
| Industrustial specialization, 1990 | -0.0006 | 0.0047 | -- | -0.0023 | 0.0044 | -- |
| | (-0.18) | (1.00) | | (-0.69) | (0.96) | |
| Relative industry wage, 1990 | -0.0051 | 0.0035 | -- | -0.0054 | 0.0056 | -- |
| | (-1.43) | (0.66) | | (-1.46) | (1.05) | |
| Entrepreneurship x YoungEstablishments | 0.0048 ** | -0.0107 *** | -- | 0.0050 ** | -0.0121 *** | -- |
| | (2.35) | (-3.67) | | (2.38) | (-4.21) | |
| Constant | 2.4173 *** | -3.7837 *** | -- | 2.4661 *** | -4.2932 *** | -- |
| | (5.23) | (-5.79) | | (4.92) | (-6.39) | |
| "$R^2$" | 0.8370 | 0.7833 | -- | 0.8328 | 0.7873 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at $p<0.01$; ** denotes significance at $p<0.05$; and * denotes significance at $p<0.10$.

Table E.21. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Business Size/Competitiveness and Industrial Specialization.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8996 *** | -0.2124 ** | -- | -- | -- |
| | | (12.14) | (-2.03) | | | |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | 0.2142 ** | -- | -- | -- |
| | | | (2.03) | | | |
| Log employment/sq. mile, 2000 | -- | -0.9066 *** | -- | -- | -- | -- |
| | | (-12.20) | | | | |
| Per capita income, 2006 | -- | 0.2679 *** | -- | -- | -- | -- |
| | | (4.05) | | | | |
| Per capita income, 2000 | -- | -- | -0.1664 *** | -- | -- | -- |
| | | | (-2.69) | | | |
| Innovation inputs factor, 1990 | -- | 0.0124 ** | 0.0052 | -- | -- | -- |
| | | (2.34) | (1.07) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | -- |
| Labor employability factor, 1990 | -- | -0.0025 | 0.0172 *** | -- | -- | -- |
| | | (-0.31) | (2.66) | | | |
| Entrepreneurial environment factor, 1990 | -- | 0.0142 *** | -0.0027 | -- | -- | -- |
| | | (4.26) | (-0.80) | | | |
| Establishment age and churning factor, 1990 | -- | 0.0075 | 0.0011 | -- | -- | -- |
| | | (0.95) | (0.18) | | | |
| Business size and competitiveness factor, 1990 | -- | -0.0303 *** | 0.0305 *** | -- | -- | -- |
| | | (-4.12) | (4.53) | | | |
| Industrustial specialization, 1990 | -- | -0.0031 | -0.0070 | -- | -- | -- |
| | | (-0.62) | (-1.53) | | | |
| Relative industry wage, 1990 | -- | 0.0037 | 0.0029 | -- | -- | -- |
| | | (0.67) | (0.58) | | | |
| SmallBusinesses x IndustrialSpecialization | -- | -0.0068 * | 0.0062 * | -- | -- | -- |
| | | (-1.79) | (1.74) | | | |
| Constant | -- | -3.3551 *** | 1.9512 *** | -- | -- | -- |
| | | (-5.05) | (3.05) | | | |
| "$R^2$" | -- | 0.7671 | 0.2502 | -- | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.22. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Business Size/Competitiveness and Relative Industry Wage.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | -- | -- | -- | -- | -- |
| Log population/sq. mile, 2000 | -0.6334 *** | -- | -- | -0.6143 *** | -- | -- |
| | (-18.65) | | | (-18.04) | | |
| Log employment/sq. mile, 2006 | 0.6352 *** | -- | -- | 0.6171 *** | -- | -- |
| | (18.39) | | | (17.80) | | |
| Log employment/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Per capita income, 2006 | -0.1308 *** | -- | -- | -0.1263 *** | -- | -- |
| | (-3.04) | | | (-2.75) | | |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -- |
| Innovation inputs factor, 1990 | -0.0085 *** | -- | -- | -- | -- | -- |
| | (-2.66) | | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -0.0021 | -- | -- |
| | | | | (-1.06) | | |
| Labor employability factor, 1990 | -0.0037 | -- | -- | -0.0029 | -- | -- |
| | (-0.75) | | | (-0.57) | | |
| Entrepreneurial environment factor, 1990 | -0.0088 *** | -- | -- | -0.0081 *** | -- | -- |
| | (-4.20) | | | (-3.85) | | |
| Establishment age and churning factor, 1990 | 0.0215 *** | -- | -- | 0.0233 *** | -- | -- |
| | (4.64) | | | (4.95) | | |
| Business size and competitiveness factor, 1990 | 0.0190 *** | -- | -- | 0.0200 *** | -- | -- |
| | (4.20) | | | (4.35) | | |
| Industrustial specialization, 1990 | 0.0017 | -- | -- | -0.0008 | -- | -- |
| | (0.55) | | | (-0.25) | | |
| Relative industry wage, 1990 | -0.0078 ** | -- | -- | -0.0076 ** | -- | -- |
| | (-2.10) | | | (-2.01) | | |
| SmallBusinesses x RelativeIndWage | -0.0064 ** | -- | -- | -0.0070 ** | -- | -- |
| | (-2.07) | | | (-2.23) | | |
| Constant | 1.8301 *** | -- | -- | 1.7664 *** | -- | -- |
| | (4.26) | | | (3.83) | | |
| "$R^2$" | 0.8393 | -- | -- | 0.8362 | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

Table E.23. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Industrial Specialization and Establishment Age/Churning.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8905 *** | -- | -- | 0.8154 *** | -- |
| | | (12.04) | | | (11.76) | |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2000 | -- | -0.9010 *** | -- | -- | -0.8265 *** | -- |
| | | (-12.15) | | | (-11.82) | |
| Per capita income, 2006 | -- | 0.2647 *** | -- | -- | 0.3032 *** | -- |
| | | (4.01) | | | (4.50) | |
| Per capita income, 2000 | -- | -- | -- | -- | -- | -- |
| Innovation inputs factor, 1990 | -- | 0.0105 ** | -- | -- | -- | -- |
| | | (2.00) | | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -0.0029 | -- |
| | | | | | (-0.98) | |
| Labor employability factor, 1990 | -- | -0.0029 | -- | -- | -0.0094 | -- |
| | | (-0.35) | | | (-1.18) | |
| Entrepreneurial environment factor, 1990 | -- | 0.0144 *** | -- | -- | 0.0123 *** | -- |
| | | (4.34) | | | (3.81) | |
| Establishment age and churning factor, 1990 | -- | 0.0097 | -- | -- | 0.0156 * | -- |
| | | (1.21) | | | (1.94) | |
| Business size and competitiveness factor, 1990 | -- | -0.0319 *** | -- | -- | -0.0280 *** | -- |
| | | (-4.41) | | | (-3.72) | |
| Industrustial specialization, 1990 | -- | -0.0007 | -- | -- | 0.0000 | -- |
| | | (-0.15) | | | (-0.01) | |
| Relative industry wage, 1990 | -- | 0.0034 | -- | -- | 0.0046 | -- |
| | | (0.62) | | | (0.82) | |
| IndustrialSpecialization x YoungEstablishments | -- | -0.0085 * | -- | -- | -0.0089 * | -- |
| | | (-1.69) | | | (-1.79) | |
| Constant | -- | -3.3001 *** | -- | -- | -3.6159 *** | -- |
| | | (-5.01) | | | (-5.36) | |
| "$R^2$" | -- | 0.7678 | -- | -- | 0.7686 | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at $p<0.01$; ** denotes significance at $p<0.05$; and * denotes significance at $p<0.10$.

Table E.24. Estimation Results of Carruthers-Mulligan Model Specification with the Interaction of Industrial Specialization and Relative Industry Wage.

| | Innovation Factor | | | Knowledge Workers Factor | | |
|---|---|---|---|---|---|---|
| Factor | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ | $\ln(p_{06}/p_{00})$ | $\ln(e_{06}/e_{00})$ | $\ln(y_{06}/y_{00})$ |
| Log population/sq. mile, 2006 | -- | 0.8998 *** | -0.2097 ** | -- | -- | -- |
| | | (12.15) | (-2.02) | | | |
| Log population/sq. mile, 2000 | -- | -- | -- | -- | -- | -- |
| Log employment/sq. mile, 2006 | -- | -- | 0.2112 ** | -- | -- | -- |
| | | | (2.02) | | | |
| Log employment/sq. mile, 2000 | -- | -0.9065 *** | -- | -- | -- | -- |
| | | (-12.20) | | | | |
| Per capita income, 2006 | -- | 0.2354 *** | -- | -- | -- | -- |
| | | (3.70) | | | | |
| Per capita income, 2000 | -- | -- | -0.1396 ** | -- | -- | -- |
| | | | (-2.34) | | | |
| Innovation inputs factor, 1990 | -- | 0.0129 ** | 0.0047 | -- | -- | -- |
| | | (2.43) | (0.96) | | | |
| Knowledge workers factor, 1990 | -- | -- | -- | -- | -- | -- |
| Labor employability factor, 1990 | -- | -0.0001 | 0.0158 ** | -- | -- | -- |
| | | (-0.02) | (2.48) | | | |
| Entrepreneurial environment factor, 1990 | -- | 0.0149 *** | -0.0033 | -- | -- | -- |
| | | (4.52) | (-1.00) | | | |
| Establishment age and churning factor, 1990 | -- | 0.0088 | -0.0005 | -- | -- | -- |
| | | (1.11) | (-0.08) | | | |
| Business size and competitiveness factor, 1990 | -- | -0.0334 *** | 0.0341 *** | -- | -- | -- |
| | | (-4.62) | (5.16) | | | |
| Industrustial specialization, 1990 | -- | -0.0035 | -0.0063 | -- | -- | -- |
| | | (-0.69) | (-1.34) | | | |
| Relative industry wage, 1990 | -- | 0.0030 | 0.0041 | -- | -- | -- |
| | | (0.54) | (0.80) | | | |
| IndustrialSpecialization x RelativeIndWage | -- | 0.0075 * | -0.0086 ** | -- | -- | -- |
| | | (1.65) | (-1.96) | | | |
| Constant | -- | -3.0328 *** | 1.6881 *** | -- | -- | -- |
| | | (-4.76) | (2.73) | | | |
| "$R^2$" | -- | 0.7677 | 0.2550 | -- | -- | -- |

Notes: The number of observations is 151; t-statistics are in parentheses; *** denotes significance at p<0.01; ** denotes significance at p<0.05; and * denotes significance at p<0.10.

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